A330
TECHNICAL TRAINING MANUAL
MECHANICAL & AVIONICS COURSE - T1+T2 (LVL 2&3)
(RR Trent 700)
AIR CONDITIONING

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AIR CONDITIONING

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AIR CONDITIONING LINE MAINTENANCE BRIEFING (2)

GENERAL

The air conditioning system maintains the air in the pressurized fuselage areas at the correct level of pressure, temperature and freshness. The pressurized areas are:
- the cockpit,
- the 6 zones of the passenger cabin,
- the lavatories and galleys areas,
- the crew rest compartments, when installed,
- the avionics compartment,
- the FWD, AFT and BULK cargo compartments.

The air conditioning system also ensures the ventilation of the air conditioning bay, which is a non-pressurized area

Air supply comes from the pneumatic system. Then, air is regulated in temperature by the temperature regulation sub-system. Correct level of air freshness in the pressurized areas and proper ventilation of the avionics equipment is ensured by the ventilation sub-system. The pressurization sub-system ensures a cabin altitude compatible with crew and passengers comfort.

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COCKPIT

FWD, MID, AFT CABIN

LAVATORIES AND GALLEYS

AVIONICS COMPARTMENT

FWD CARGO

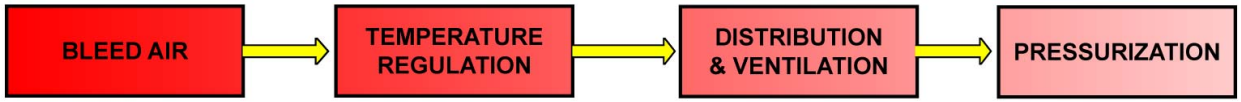
AFT CARGO

BULK CARGO

CREW REST COMPARTMENT

AIR CONDITIONING BAY VENTILATION

NON PRESSURIZED AREA



GENERAL

AIR CONDITIONING LINE MAINTENANCE BRIEFING (2)

TEMPERATURE CONTROL AND RE-CIRCULATION

Bleed air coming from the pneumatic system is first regulated in flow by two pack flow control valves controlled by the Pack Controllers (PCs) according to flow demand inputs received from the AIR panel and the Zone Controller (ZC).
Bleed air is then delivered to two independent air conditioning packs which ensure basic temperature regulation. Each air conditioning pack mainly consists of an Air Cycle Machine (ACM) and heat exchangers using ram air flowing through ram air inlet and ram air outlet flaps. Pack temperature regulation is controlled by the associated PC according to a temperature demand computed by the ZC based upon inputs received from the AIR panel and the Flight Attendant Panel (FAP).
The cooled fresh air is then fed into a mixer unit.
On ground, a ground cart supplies preconditioned air through Low Pressure (LP) ground connectors. In flight, if both packs are inoperative, an emergency ram air inlet will enable to maintain air supply to the cabin. The emergency ram air supply is directly controlled from the AIR panel.
Fine temperature adjustment of air distributed in the pressurized zones is obtained by controlling the amount of hot air added to the air coming from the mixer unit. This is under the control of the ZC according to the temperature demand inputs received from the AIR panel and the FAP.
A part of cabin air is re-circulated by re-circulation fans through re-circulation valves in order to limit the bleed air demand on the engines. This re-circulated air is mixed with fresh air coming from the air conditioning packs into the mixer unit. Re-circulated air is also used for avionics ventilation purpose. The re-circulation fans and valves are controlled by the Ventilation Controller (VC). The re-circulation fans can be manually switched off from the VENTILATION panel.

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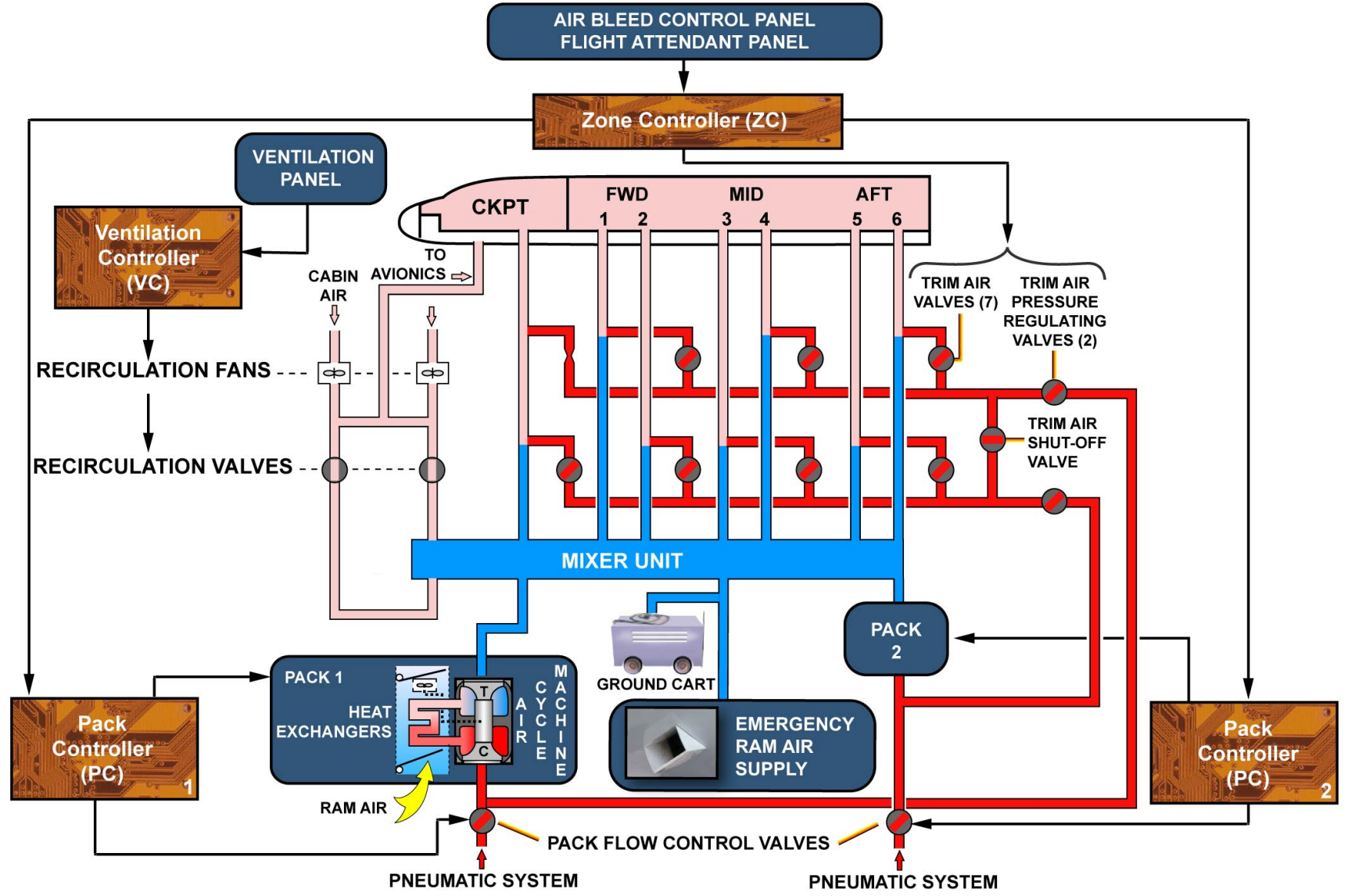

TEMPERATURE CONTROL AND RE-CIRCULATION

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AIR CONDITIONING LINE MAINTENANCE BRIEFING (2)

AVIONICS AND AIR CONDITIONING COMPT VENTILATION

The two re-circulation fans used for cabin air re-circulation are also used as blower fans for the avionics equipment ventilation. The system carries out proper ventilation of the rack equipment and various panels in order to avoid any overheat condition. It operates continuously whenever aircraft electrical power is available. An extract fan extracts the air from the avionics equipment ventilation. Air is discharged either overboard through the overboard valve or under the cargo floor through the underfloor valve. When the overboard valve is open, the underfloor valve is closed and vice versa. The Avionics Equipment Ventilation Computer (AEVC) controls and monitors the avionics ventilation system. A manual override is possible from the VENTILATION panel.
The air conditioning bay is ventilated on ground and in flight as soon as the air conditioning packs operate in order to avoid any overheat condition in this compartment. The air conditioning bay ventilation system uses RAM air through NACA inlet to cool down the compartment. The system is monitored by the AEVC.

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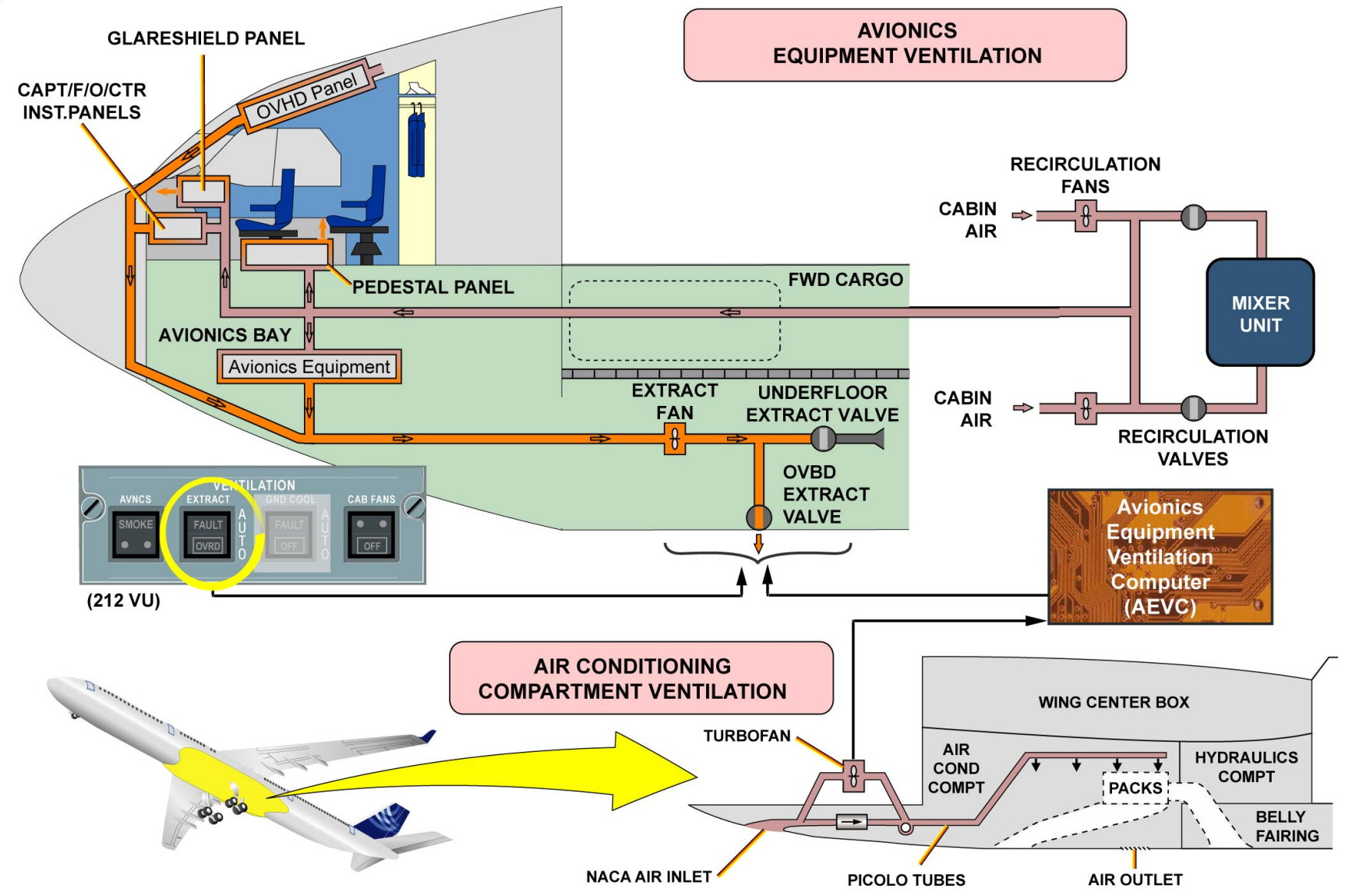

AVIONICS AND AIR CONDITIONING COMPT VENTILATION

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AIR CONDITIONING LINE MAINTENANCE BRIEFING (2)

PRESSURIZATION

The pressurization system makes sure that cabin altitude is safe and compatible with crew and passenger comfort. The cabin pressurization is done by controlling the amount of cabin air discharged overboard through two outflow valves located on the lower part of the aircraft fuselage. The system is controlled automatically by the Cabin Pressure Controllers (CPCs), or manually from the CABIN PRESS panel.
When the aircraft is on ground, the Residual Pressure Control Unit (RPCU) forces both outflow valves to move to the fully open position, overriding the automatic control from CPCs and the manual control as well. This is to prevent any violent door opening in case of residual cabin pressure.
Three safety valves are installed at the rear pressure bulkhead to prevent excessive positive or negative differential pressure. Due to the large volume of the fuselage, one negative-pressure relief valve helps the safety valves to prevent negative differential pressure.

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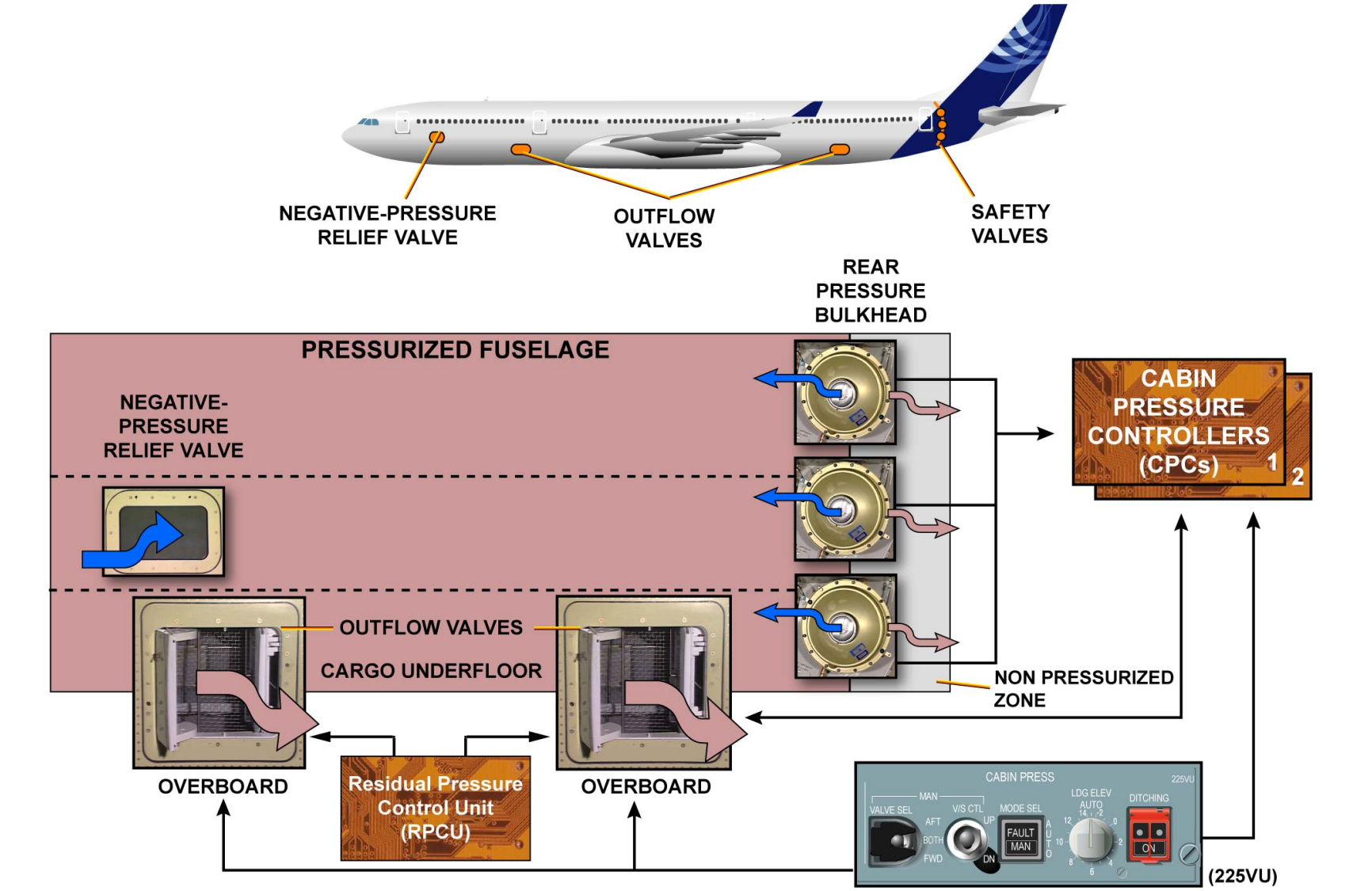

PRESSURIZATION

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AIR CONDITIONING LINE MAINTENANCE BRIEFING (2)

DEACTIVATION OF THE TURBOFAN SUPPLY LINE

WARNING: MAKE SURE THAT AIR IS NOT SUPPLIED TO THE AIR CONDITIONING SYSTEM FROM THE MAIN ENGINE, THE APU OR THE GROUND SOURCE. HOT COMPRESSED AIR CAN CAUSE INJURY TO STAFF. DO NOT TOUCH COMPONENTS UNTIL THEY ARE SUFFICIENTLY COOL TO PREVENT BURNING INJURIES.

Make sure that all BLEED P/Bs are released out and tagged. Put a warning notice on the HP ground connector as well.
Remove the applicable belly fairing panel(s) for access.
Disconnect the supply line from the turbofan. Connect the supply line to the dummy connection on the structure and put blanking plugs on the disconnected line end.
To deactivate the mechanic call horn you must have access to the left relay plate in the avionic bay; the dedicated pin of the turbofan must be disconnected from the terminal block on the left relay plate. Only turbofan monitoring is deactivated, but the related warning stays in view. The call horn remains functional for the other functions.

NOTE: As an alternative, you can push the HORN RESET P/B on the external power control panel. This panel is on the fuselage behind the NLG. This stops the mechanic call horn but you will hear it again after the subsequent flight if the fault continues.

If no other deactivation servicing tasks have to be performed, the area can be closed. All tools, test and support used during this procedure should be removed.

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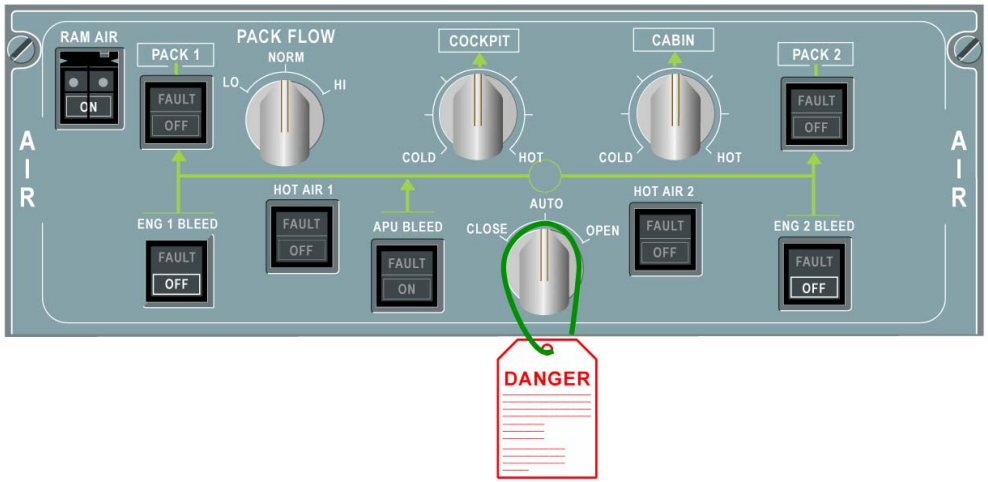
✓ SAFETY PRECAUTIONS

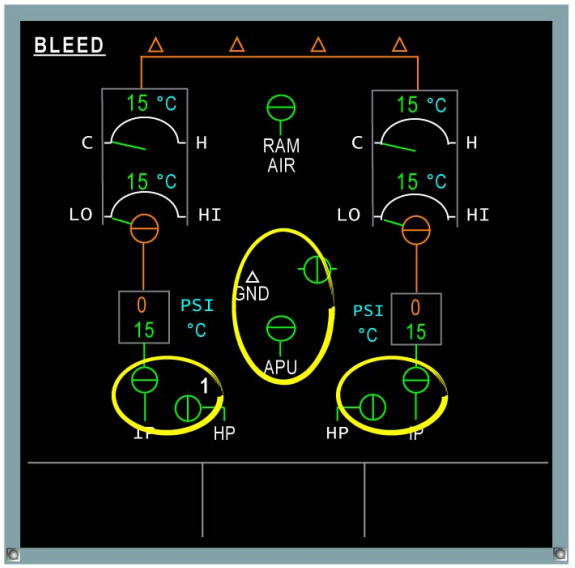
WARNING

MAKE SURE THAT AIR IS NOT SUPPLIED TO THE AIR CONDITIONING SYSTEM FROM THE MAIN ENGINE, THE APU OR A GROUND SOURCE.
HOT COMPRESSED AIR CAN CAUSE INJURY TO STAFF.
DO NOT TOUCH COMPONENTS UNTIL THEY ARE SUFFICIENTLY COOL TO PREVENT BURNING INJUIES.

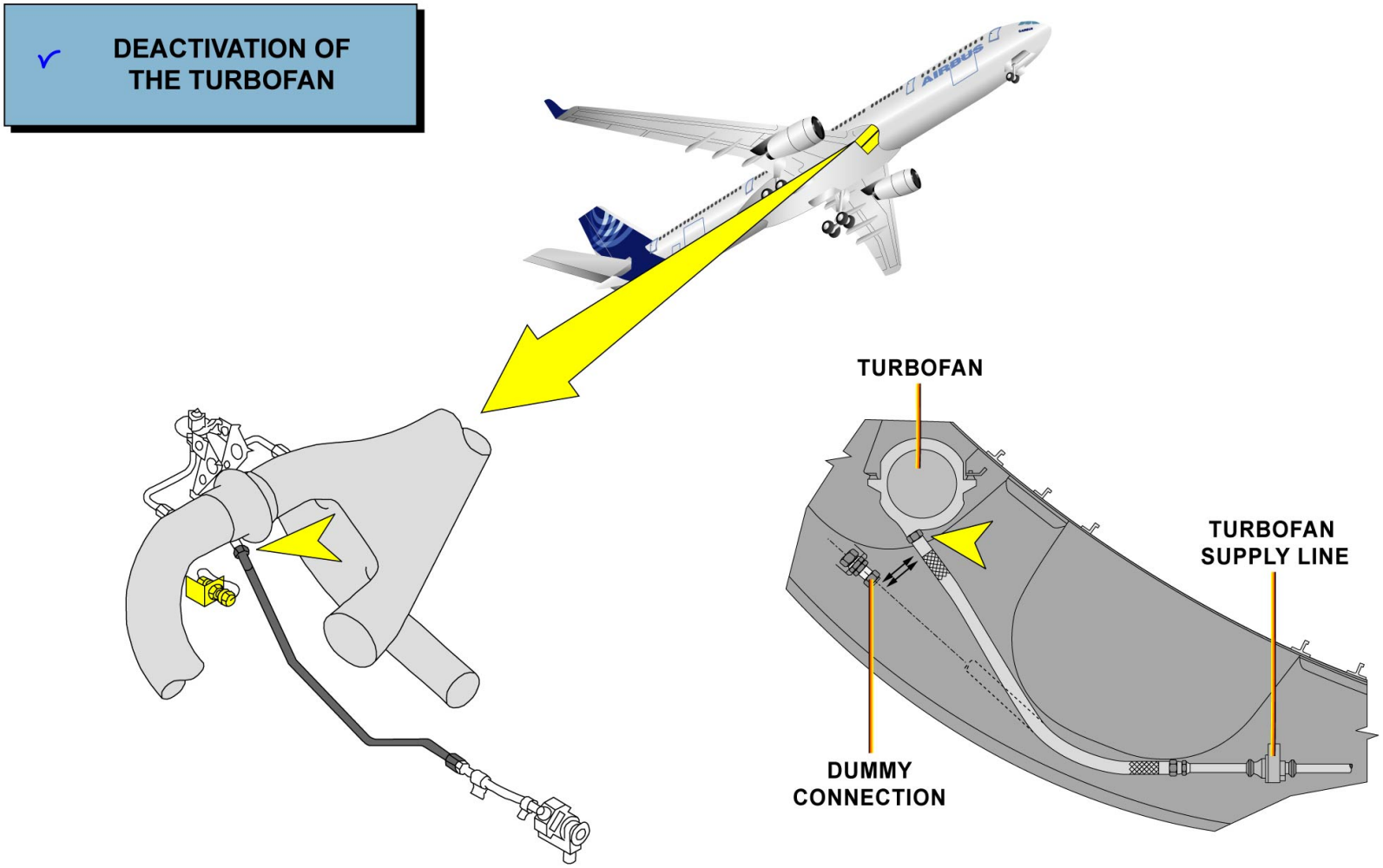
HP GROUND CONNECTORS

ECAM SD

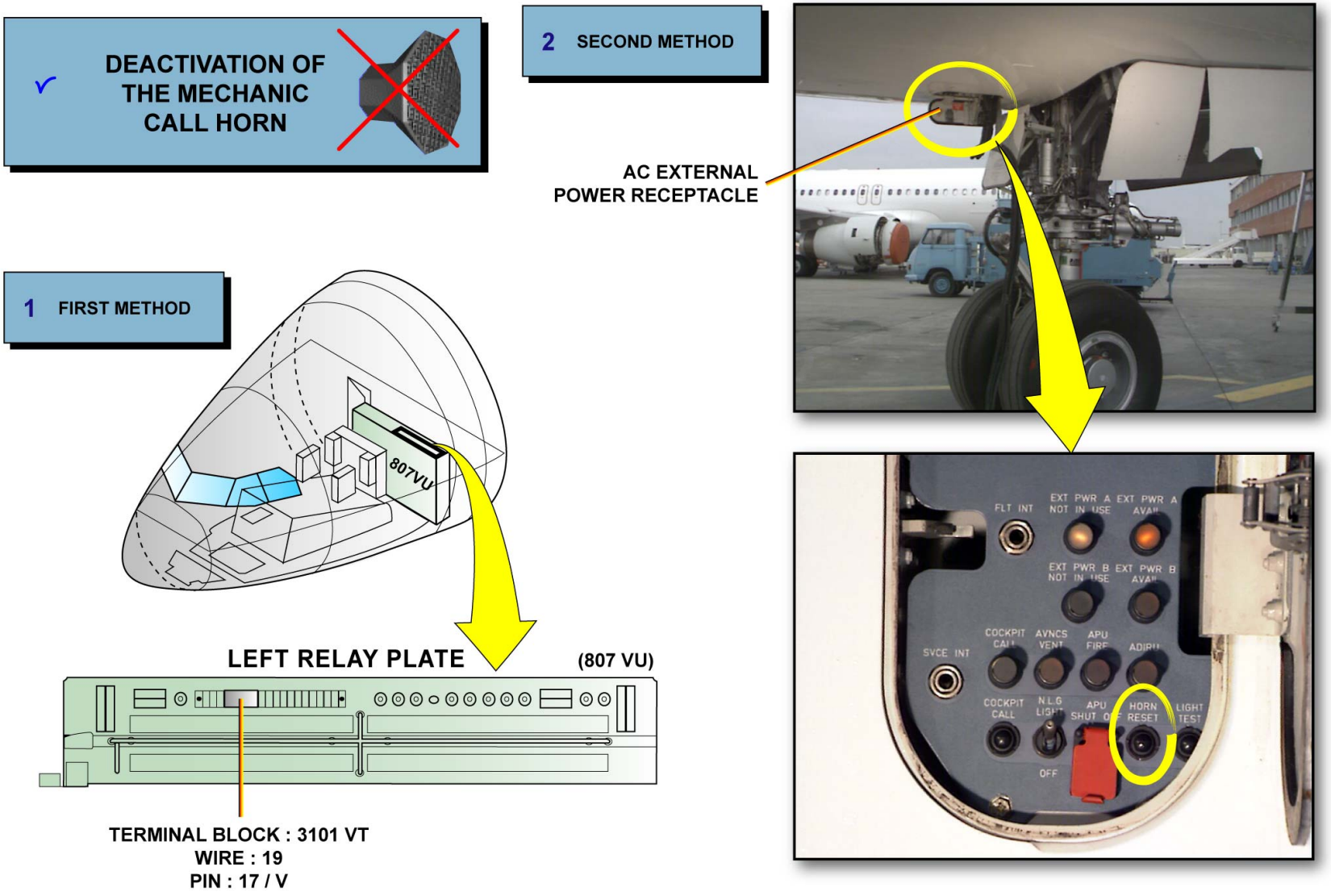




DEACTIVATION OF THE TURBOFAN SUPPLY LINE



DEACTIVATION OF THE TURBOFAN SUPPLY LINE



DEACTIVATION OF THE TURBOFAN SUPPLY LINE

AIR CONDITIONING LINE MAINTENANCE BRIEFING (2)

DEACTIVATION OF THE AVIONICS VENTILATION OVERBOARD EXTRACT VALVE

Make sure that all engines are shut down and that the Full Authority Digital Engine Control GrouND PoWeR(FADEC GND PWR) P/Bs are not selected ON.

CAUTION: DO NOT USE YOUR FINGERS TO SET THE SWITCHES TO THE "ON" POSITION. USE A STICK, AND BE VERY CAREFUL TO THE HANDLE THAT WILL ROTATE IF THE AVIONICS EQUIPMENT VENTILATION COMPUTER (AEVC) SET THE VALVE TO THE CLOSED POSITION.

In case of a failure, the avionics ventilation overboard extract valve can be manually operated and deactivated in the open position for normal operation on the ground:
- push to release the handle from its recess,
- pull the handle out,
- set the deactivation switch to OFF,
- pull the handle further to engage the drive mechanism,
- fold out the handle and turn clockwise until the main flap is Fully Open (FO),
- fold and latch the handle.

For dispatch the valve must be deactivated with the main flap closed and the auxiliary flap open:
- push to release the handle from its recess,
- pull the handle out,
- set the deactivation switch to OFF,
- pull the handle further to engage the drive mechanism,
- fold out the handle and turn it counterclockwise until the main flap is Fully Closed (FC) and the auxiliary flap is still open,
- fold and latch the handle.

If no other deactivation servicing tasks have to be performed, the area can be closed. All tools, test and support used during this procedure have to be removed.

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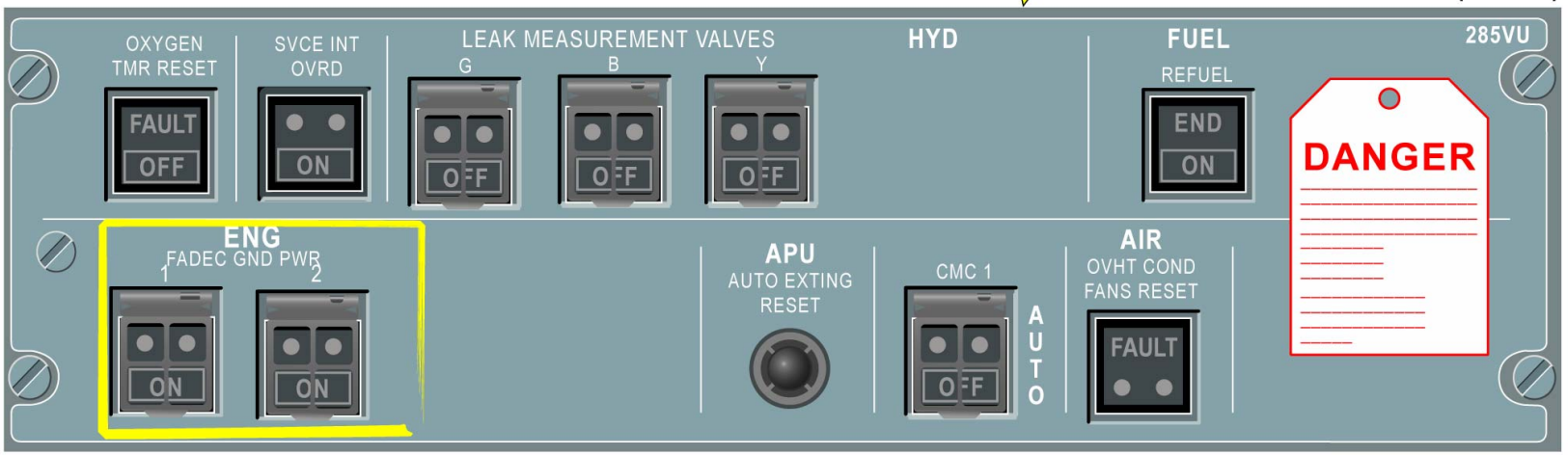
✓ JOB SET-UP

✓ ENGINE SHUT DOWN

(285VU)



DEACTIVATION OF THE AVIONICS VENTILATION OVERBOARD EXTRACT VALVE

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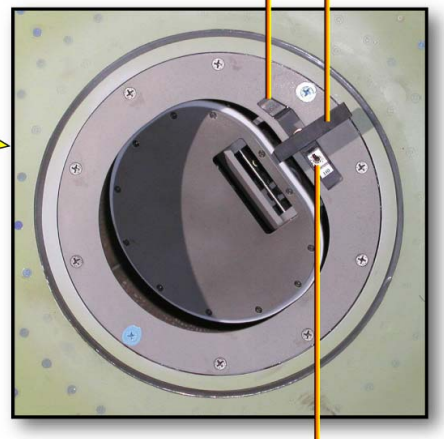
✓ DEACTIVATION OF THE AVIONICS VENTILATION OVERBOARD EXTRACT VALVE IN FULLY OPEN POSITION FOR GROUND OPERATIONS WITH THE ENGINE STOPPED.



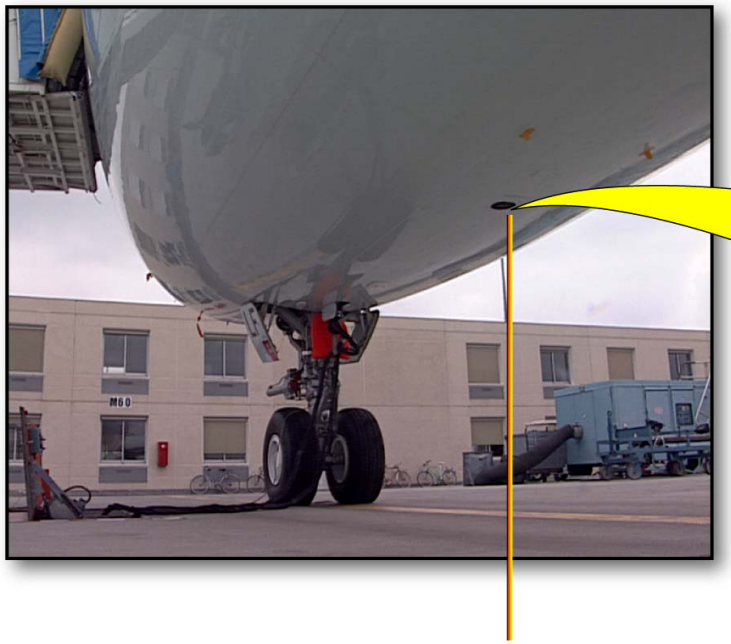
FULLY OPEN POSITION (GROUND OPS ONLY)

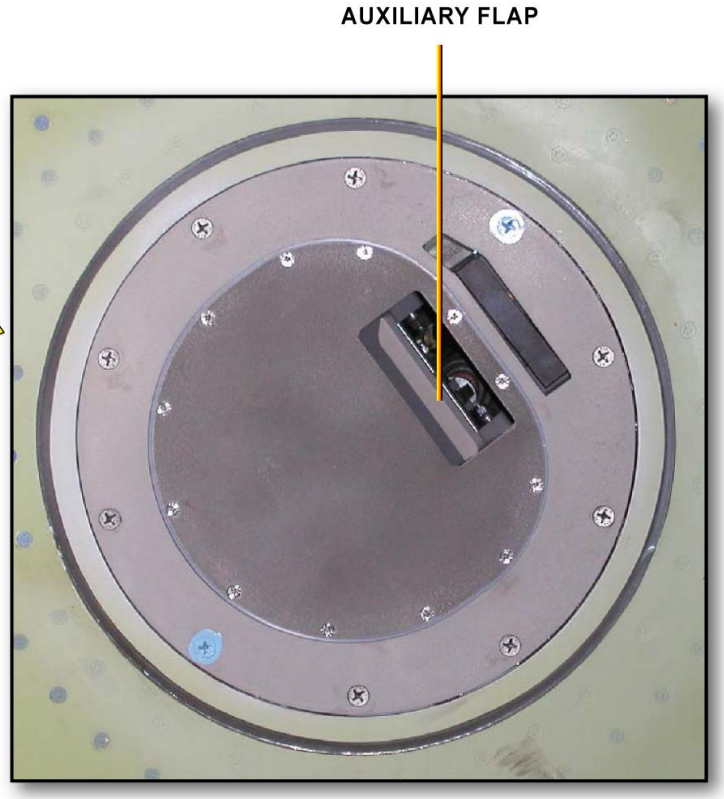
CAUTION

DO NOT USE YOUR FINGERS TO SET THE SWITCHES TO THE "ON" POSITION USE A STICK, AND BE VERY CAREFUL. THE AVIONICS EQUIPMENT VENTILATION COMPUTER (AEVC) WILL POSSIBLY PUT THE SKIN VALVES DIRECTLY IN THE CLOSED POSITION AND THEY WILL CUT YOUR FINGERS.

DEACTIVATION OF THE AVIONICS VENTILATION OVERBOARD EXTRACT VALVE

✓ DEACTIVATION OF THE AVIONICS VENTILATION OVERBOARD EXTRACT VALVE IN NOT FULLY OPEN POSITION A SHORT TIME BEFORE ENGINE START FOR DISPATCH PER MMEL.





MAIN FLAP CLOSED, AUXILIARY FLAP OPEN
(PARTIALLY OPEN POSITION / DISPATCH POSITION)

DEACTIVATION OF THE AVIONICS VENTILATION OVERBOARD EXTRACT VALVE

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AIR CONDITIONING LINE MAINTENANCE BRIEFING (2)

DEACTIVATION OF THE PACK FLOW CONTROL VALVE

WARNING: MAKE SURE THAT AIR IS NOT SUPPLIED TO THE AIR CONDITIONING SYSTEM FROM THE MAIN ENGINE, THE APU OR A GROUND SOURCE. HOT COMPRESSED AIR CAN CAUSE INJURY TO STAFF. DO NOT TOUCH COMPONENTS UNTIL THEY ARE SUFFICIENTLY COOL TO PREVENT BURNING INJURIES.

Make sure that all BLEED P/Bs are released out and tagged. Put a warning notice on the HP and LP ground connectors as well.

Release PACK 1 or 2 P/BSW to the OFF position, and open the applicable RESET Circuit Breaker (C/B) - PACK CONT 1 for pack 1 or PACK CONT 2 for pack 2. Remove the applicable belly fairing panel(s) for access.

Remove the lockwire from the locking screw and move the locking screw from position 1 to position 2.

Close the applicable RESET C/B.

The area can be closed. All tools, test, support and warning notices used during this procedure should be removed.

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✓ SAFETY PRECAUTIONS

WARNING

MAKE SURE THAT AIR IS NOT SUPPLIED TO THE AIR CONDITIONING SYSTEM FROM THE MAIN ENGINE, THE APU OR A GROUND SOURCE.
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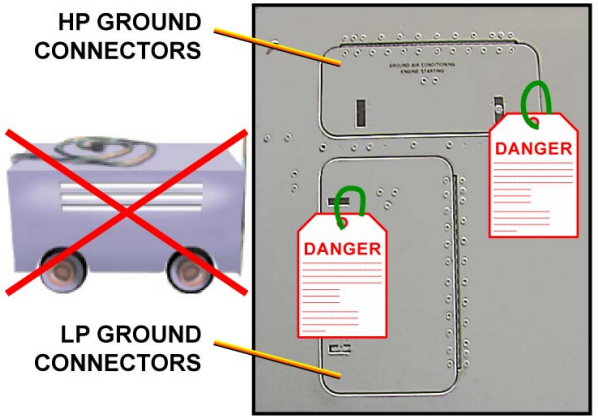
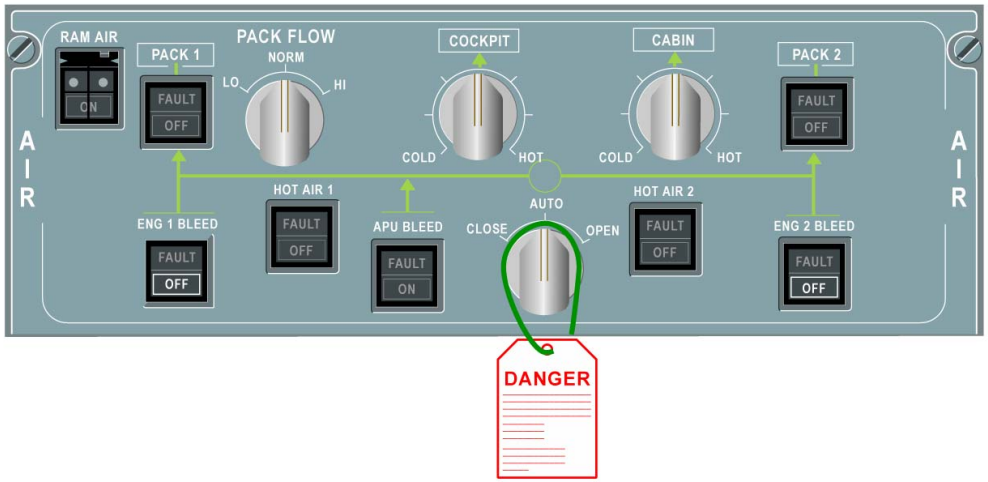
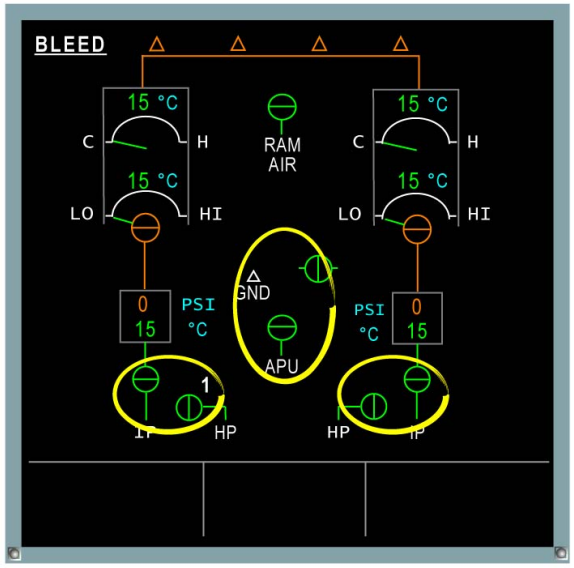
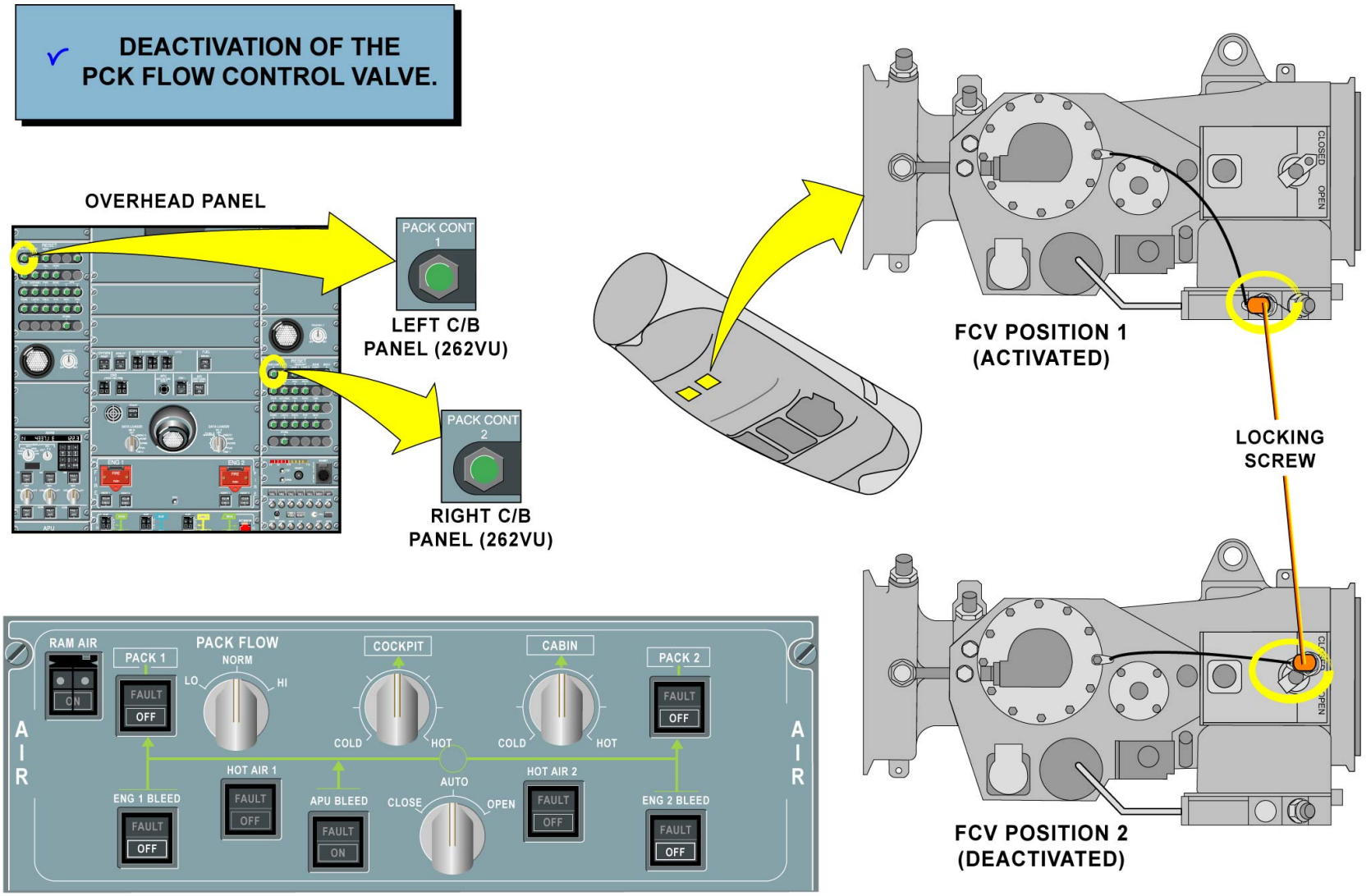




ECAM SD



DEACTIVATION OF THE PACK FLOW CONTROL VALVE



DEACTIVATION OF THE PACK FLOW CONTROL VALVE

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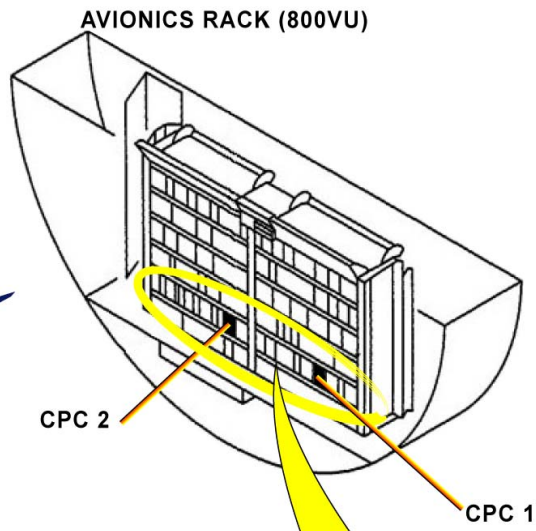
AIR CONDITIONING LINE MAINTENANCE BRIEFING (2)

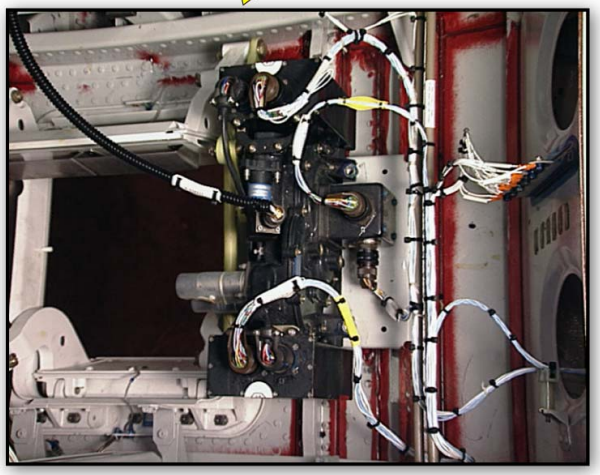
PRESSURIZATION SYSTEM MAINTENANCE TIPS

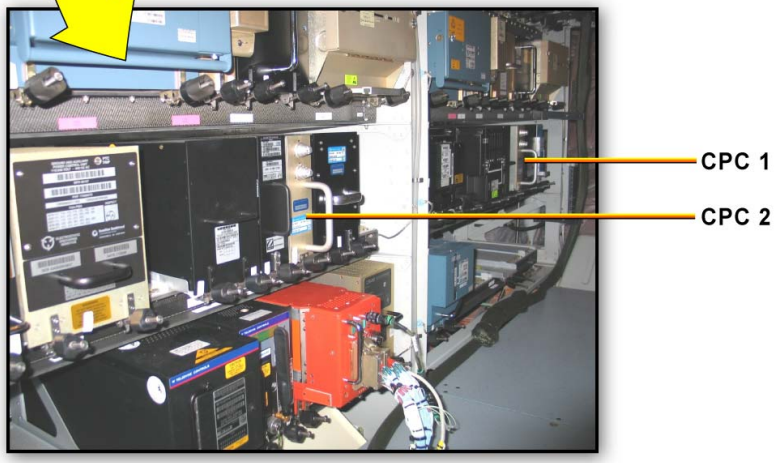
For the pressurization system, the automatic cabin pressure control system 1 or 2, may be inoperative provided cabin pressure indications are operative on ECAM in manual mode.
The cabin pressure indications on ECAM are provided by the CPC fitted at the position of the system 1.



ECAM SD

OUTFLOW VALVE





PRESSURIZATION SYSTEM MAINTENANCE TIPS

AIR CONDITIONING SYSTEM OVERVIEW (3)

AIR CONDITIONING SYSTEM OVERVIEW

Bleed air coming from the pneumatic system is first regulated in flow by two pack flow control valves controlled by the Pack Controllers (PCs) according to flow demand inputs received from the AIR panel and the Zone Controller (ZC).
Bleed air is then delivered to two independent air conditioning packs, which make sure that basic temperature is regulated. Each air conditioning pack mainly has an Air Cycle Machine (ACM) and heat exchangers using ram air flowing through ram air inlet and ram air outlet flaps. Pack temperature regulation is controlled by the related PC according to a temperature demand computed by the ZC based upon inputs received from the AIR panel and the Flight Attendant Panel (FAP).
The cooled fresh air is then fed into a mixer unit.
On ground, a ground cart supplies preconditioned air through Low Pressure (LP) ground connectors. In flight, if both packs are inoperative, an emergency ram air inlet will help to maintain air supply to the cabin. The emergency ram air supply is directly controlled from the AIR panel.
Fine temperature adjustment of air distributed in the pressurized zones is obtained by controlling the amount of hot air added to the air coming from the mixer unit. This air temperature adjustment is done under the control of the ZC according to the temperature demand inputs received from the AIR panel and the FAP.
A part of cabin air is re-circulated by re-circulation fans through re-circulation valves in order to limit the bleed air demand on the engines. This re-circulated air is mixed with fresh air coming from the air conditioning packs into the mixer unit. Re-circulated air is also used for avionics ventilation. The Ventilation Controller (VC) controls the re-circulation fans and valves The re-circulation fans can be manually switched off from the VENTILATION panel.

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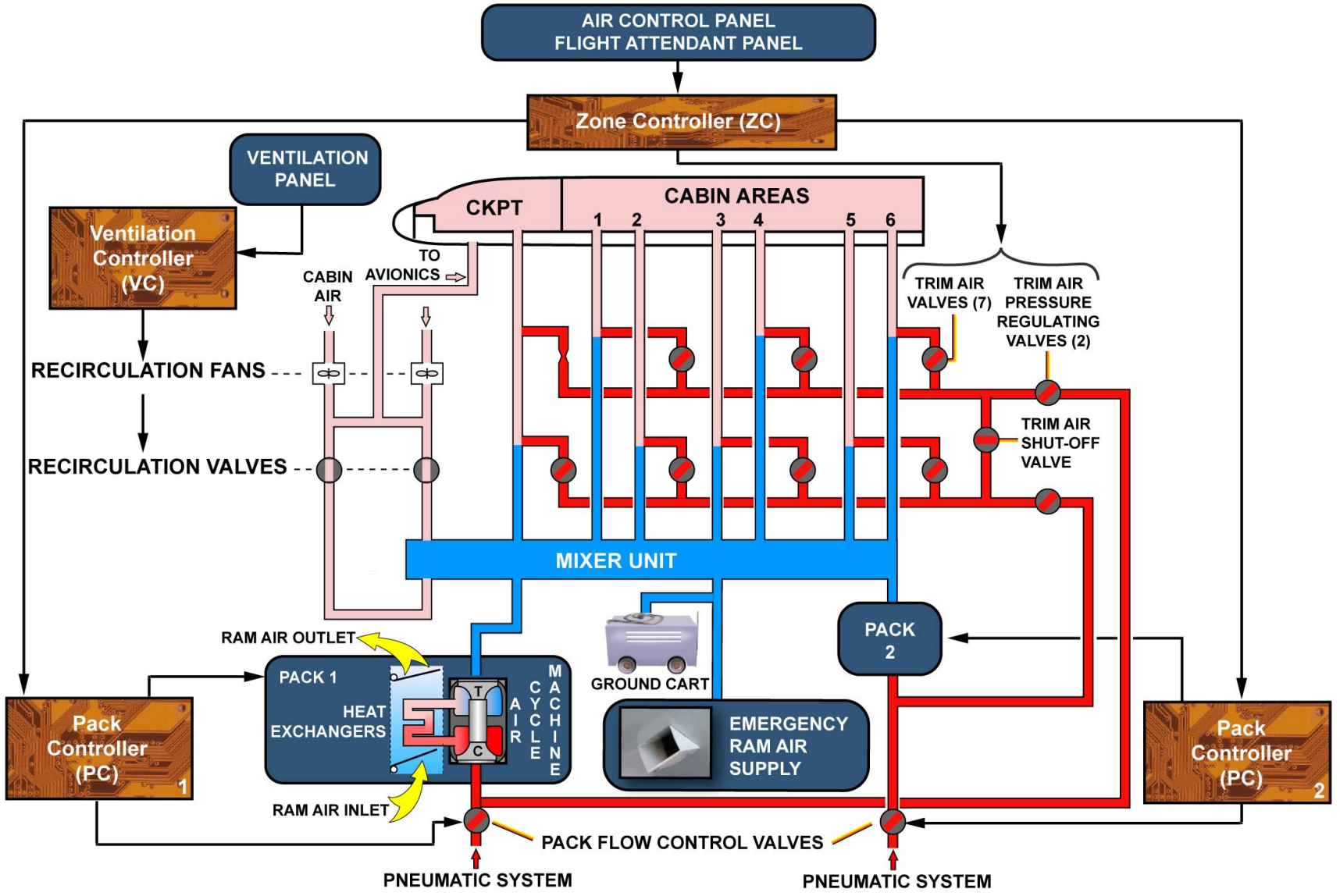

AIR CONDITIONING SYSTEM OVERVIEW

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PACK AIR FLOW REGULATION D/O (3)

SYSTEM DESCRIPTION

The system ensures:
- pack air flow regulation and shut-off,
- pack air flow measurement,
- ozone filtering.

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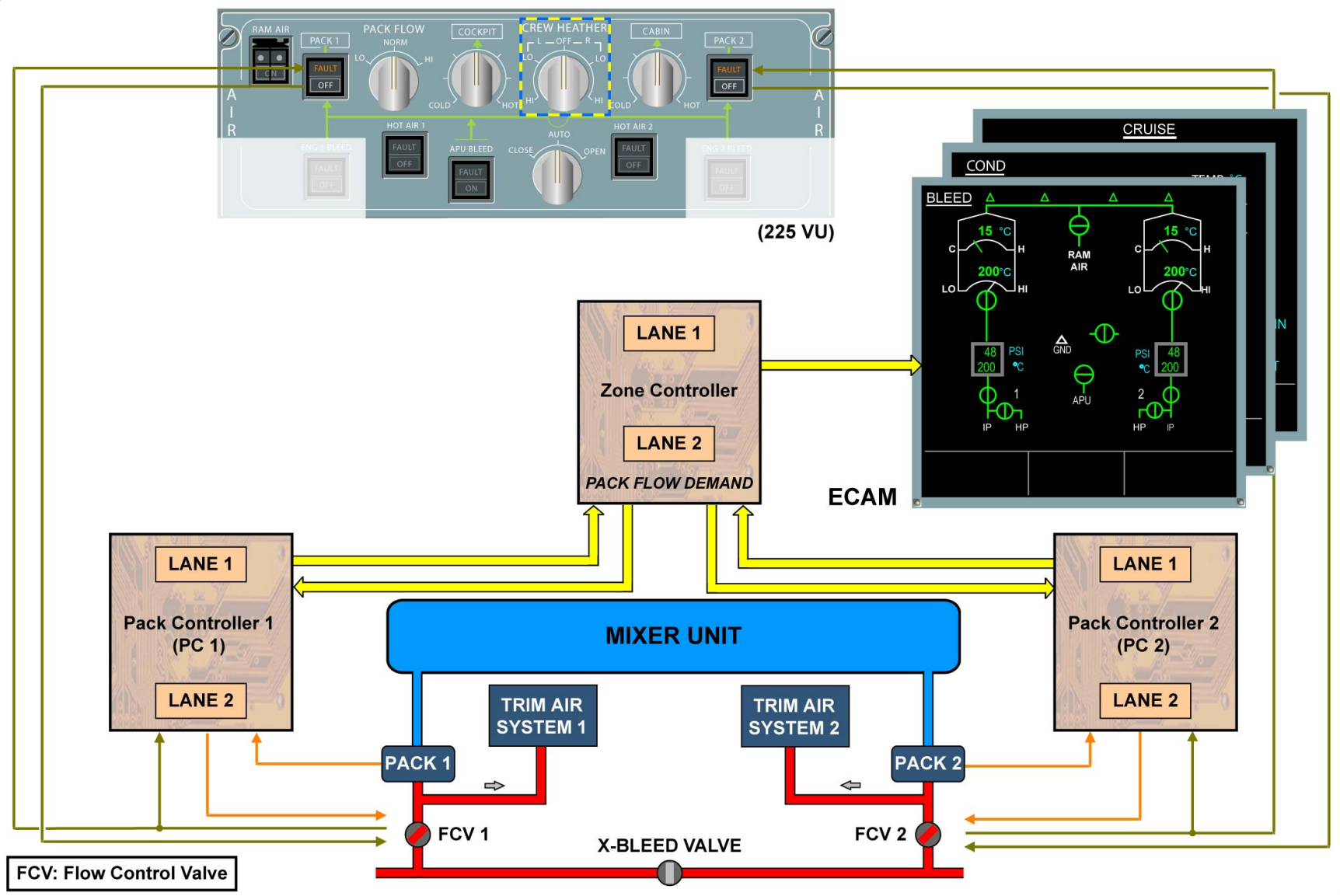

SYSTEM DESCRIPTION

PACK AIR FLOW REGULATION D/O (3)

SYSTEM DESCRIPTION (continued)

FLOW CONTROL VALVE (FCV)

The Flow Control Valve (FCV) is a modulating and shut-off butterfly valve. It is controlled by the Pack Controller (PC). The FCV is pneumatically actuated and:
- electrically controlled through an electrical pressure regulator (normal mode),
- pneumatically controlled through a pneumatic pressure regulator (back-up mode).\
The electrical pressure regulator is fitted with a torque motor. The pneumatic pressure regulator is supplied directly with cabin pressure. The normal/back-up mode switching is ensured by a control solenoid. The shut-off function is ensured by an on/off solenoid. Two microswitches ensure the valve Fully Closed (FC)/Not Fully Closed (NFC) position detection. The FCV is fitted with a mechanical visual indicator and a locking screw for maintenance purposes.

SENSORS

Four different sensors are used for the actual pack airflow calculation:
- two flow sensors measure the differential pressure through the FCV,
- a pack inlet pressure sensor reads the air pressure upstream from the FCV,
- a bleed temperature sensor reads the air temperature upstream from the FCV.

OZONE CONVERTER

An ozone converter is fitted in the hot bleed air supply duct upstream from the FCV. The ozone converter removes the ozone from the air by catalytic effect.

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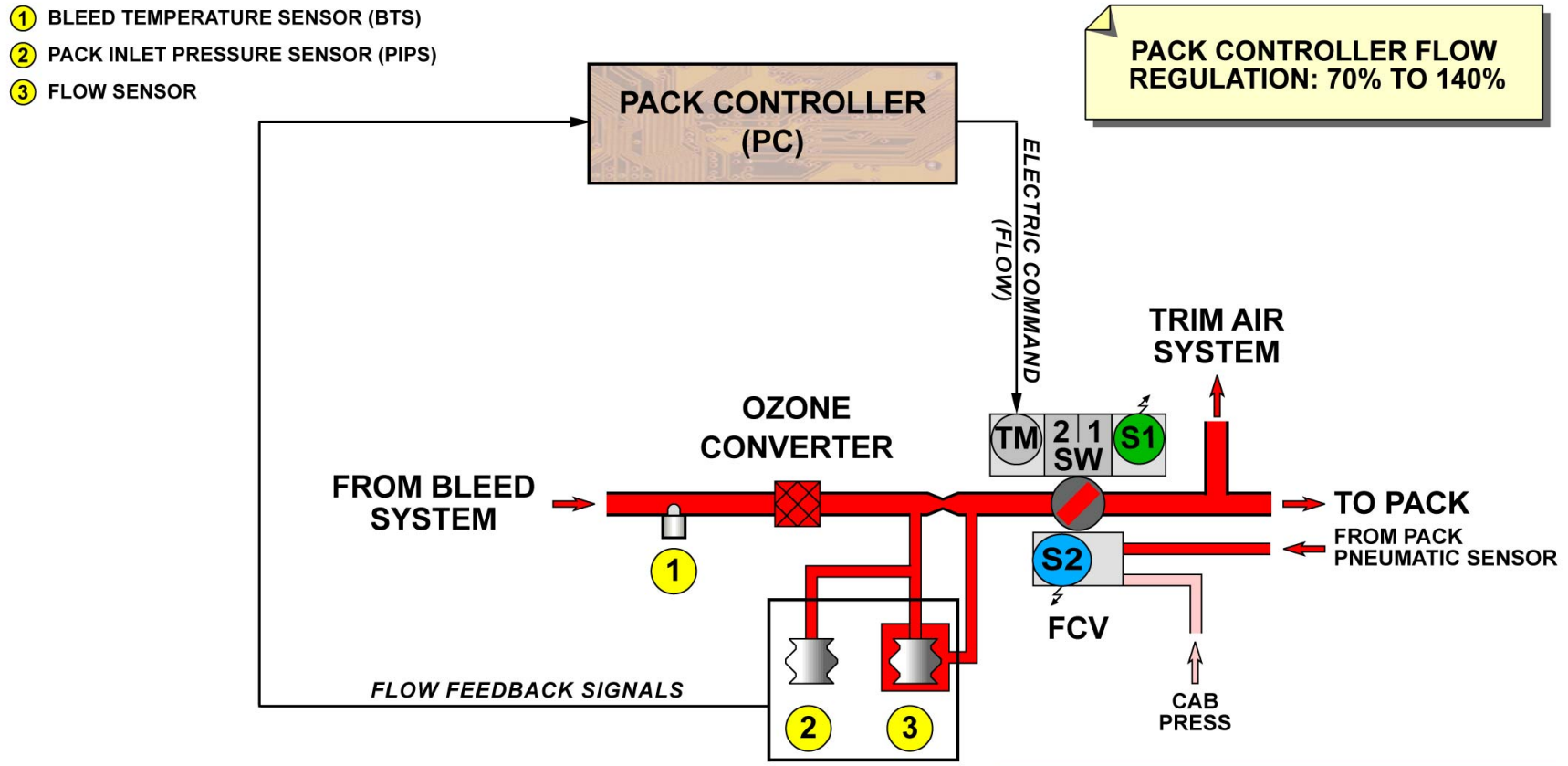
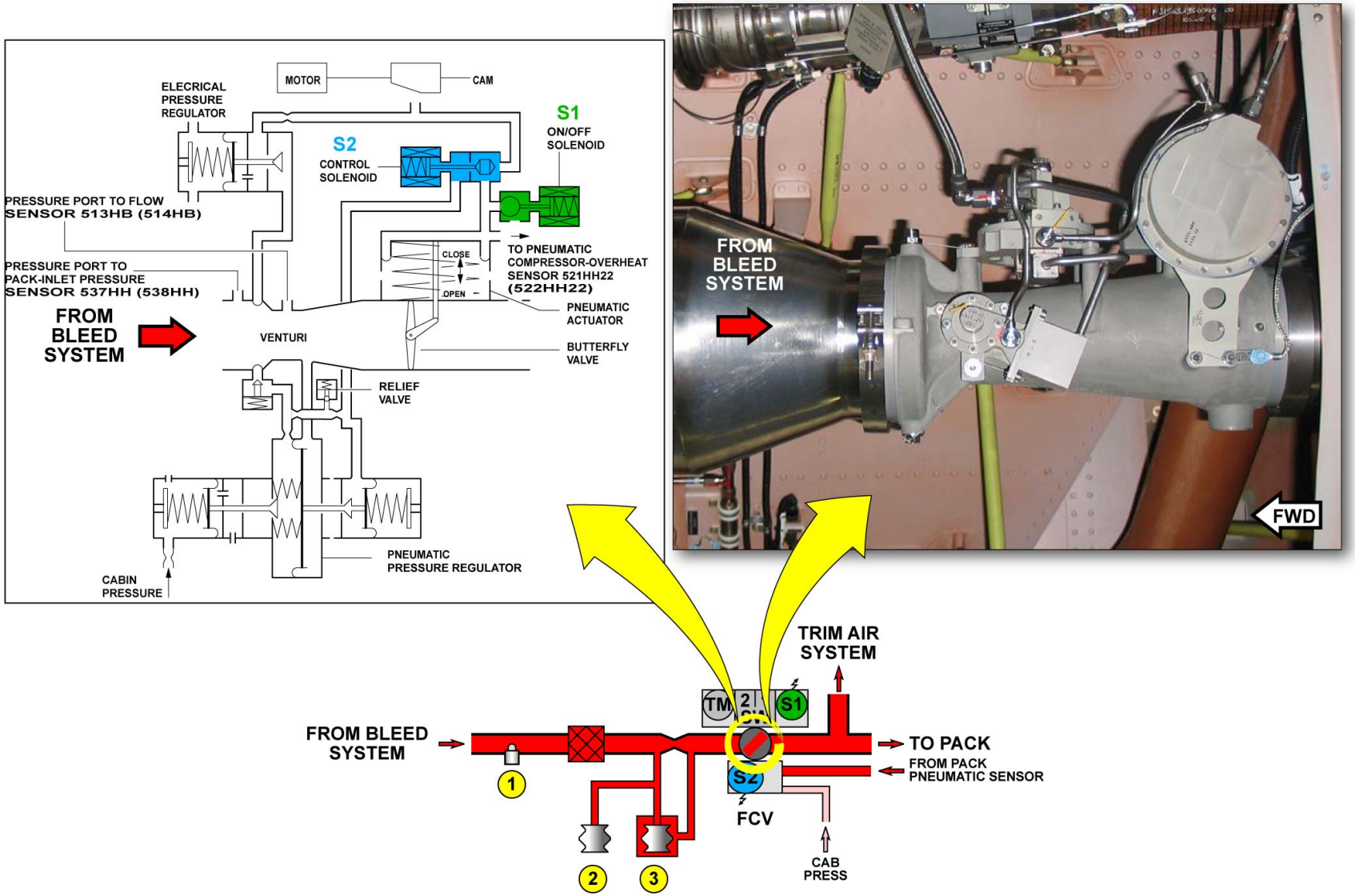


	S1 SOLENOID (ON/OFF COMMAND)	S2 SOLENOID (BACK-UP CONTROL)
ENERGIZED ⚡	FCV CLOSED	FCV REGULATING
DE-ENERGIZED	FCV CONTROLLED by PC	FCV IN PNEUMATIC MODE

SYSTEM DESCRIPTION - FLOW CONTROL VALVE (FCV) ... OZONE CONVERTER

G9409341 - GAUT0T0 - FM21D1AIRFLOW03



SYSTEM DESCRIPTION - FLOW CONTROL VALVE (FCV) ... OZONE CONVERTER

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PACK AIR FLOW REGULATION D/O (3)

PACK FLOW REGULATION

Each FCV has two different flow regulation modes. In this module we describe only the FCV 1 system. The normal mode operates as long as the control solenoid is energized by the PC. The pneumatic back-up mode takes over when the control solenoid is not energized.

NORMAL MODE

The PC controls the electrical pressure regulator through a torque motor. The PC compares the pack flow demand received from the ZC to the actual flow. The actual flow is calculated by the PC and based on:
- two differential pressure inputs,
- the bleed air temperature,
- the pack inlet pressure,
- the cabin altitude.

PNEUMATIC BACK-UP MODE

The pneumatic back-up mode operates if the control solenoid electrical power supply is lost or the electrical pressure regulator torque motor fails. The pneumatic pressure regulator regulates the flow to 125% and keeps it constant according to:
- a differential pressure measured within the FCV,
- a pneumatic cabin pressure input.

The FCVs pneumatically close if the pack inlet pressure drops below 5 PSI.

INDICATING

The FCV position, the actual flow and the pack flow demand target data for normal mode are transmitted to the EIS through the ZC. These indications are displayed on the ECAM BLEED page.

FCV SHUT-OFF

The FCV shut-off is ensured by the on/off solenoid. The FCV closes when the on/off solenoid is energized. The FCV flow regulation is enabled when the on/off solenoid is de-energized. A pack closure relay directly commands the on/off solenoid according to:
- the associated PACK P/BSW position,
- an engine start/relight condition,
- an engine fire condition,
- the DITCHING P/BSW position,
- the cabin and cargo doors status.

ON/OFF FUNCTION

FCV 1 closes when the PACK 1 P/BSW is set to OFF. FCV 2 closes when the PACK 2 P/BSW is set to OFF.

ENGINE START/RELIGHT

Each PC closes its associated FCV as soon as an engine start or relight sequence is initiated. EIVMU 1 transmits engine start data to PC 1 for control of FCV 1. EIVMU 2 transmits engine start data to PC 2 for control of FCV 2. The FCV opens at the end of the start sequence in flight or after a delay following the start sequence on ground. The EIVMU will not generate an FCV closure signal during an engine relight in flight with N2>50% (N3>50% for RR engine). Both FCVs close if an engine start occurs with the crossbleed valve in open position.

ENGINE FIRE

FCV 1 closes if ENGine 1 FIRE P/BSW is released out. FCV 2 closes if ENG 2 FIRE P/BSW is released out.

DITCHING

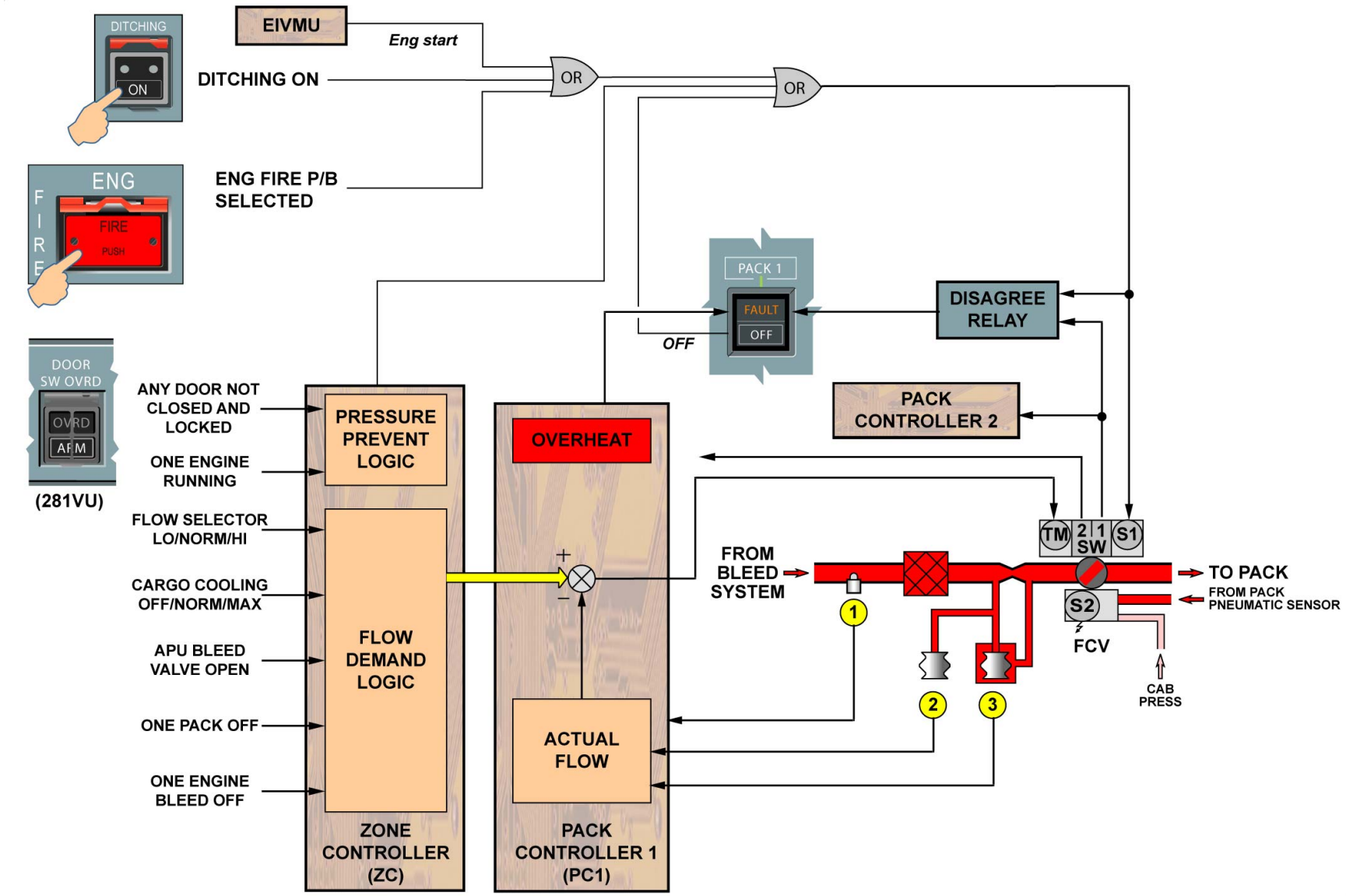
Both FCVs close as soon as the DITCHING P/BSW is set to ON. The ditching signal is transmitted to each pack close relay via a ditching relay.

DOORS NOT CLOSED AND LOCKED

The ZC checks the door status inputs after the first engine is started and continuously monitors the door status until the throttle lever are set to take-off power (flight phase 2). During flight phase 2, the PC will automatically close both FCVs to prevent fuselage pressurization if the door status is "doors not closed and locked". The PC will open both FCVs as soon as the door status becomes "doors closed and locked".
From flight phase 3, the latest door status monitored during phase 2 will be memorized and latched. The memorized door status will be reset and the actual door status monitoring resumed if at least throttle lever 2 or 3 is removed from the take-off power position and the A/C is on ground.

FCV POSITION DISAGREEMENT

A FAULT light comes on, on the PACK 1(2) P/BSW when the FCV 1(2) position disagrees with the commanded position. The fault light is triggered through an FCV 1(2) disagree relay. An associated ECAM warning message will be triggered on the EWD.
The override function has a DOOR SW OVeRriDe P/B installed on the cockpit overhead panel. The DOOR SW OVRD P/B can be used for a manual override of a failure. This function is used for the aircraft dispatch and with the MEL procedure.



PACK FLOW REGULATION ... FCV POSITION DISAGREEMENT

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PACK AIR FLOW REGULATION D/O (3)

PACK FLOW DEMAND

The pack flow demand calculation is performed by the Zone Controller (ZC). It is used as a target value by each PC for controlling the FCVs. The pack flow demand basically depends on the AIR FLOW selector position. The pack flow demand is set to:
- 100% if the selector is in MAN position,
- 80% if the selector is in LO position.

The demand is variable if the selector is in NORM or HIGH position.

AIR MANAGEMENT

The air management function ensures a fuel consumption reduction without affecting passenger comfort. It calculates a pack flow demand based on:
- the NORM/HIGH AIR FLOW selector position,
- the cabin layout from the Cabin Intercommunication Data System (CIDS).

CARGO OFFSET

The pack flow demand is offset if optional cargo compartment heating or cooling systems are installed. The offset depends on:
- the FWD cargo cold air valve position, if installed,
- the aft cargo cold air valve position, if installed.

These positions are transmitted by the Ventilation Controller (VC).

LOWER DECK FACILITY OFFSET

The pack flow demand is also offset if an optional lower deck facility is installed. The offset value depends on the lower deck facility configuration transmitted by the CIDS.

ONE BLEED OFF

The pack flow demand is limited if both packs are operative and one engine bleed air system is off.

APU BLEED AIR SUPPLY

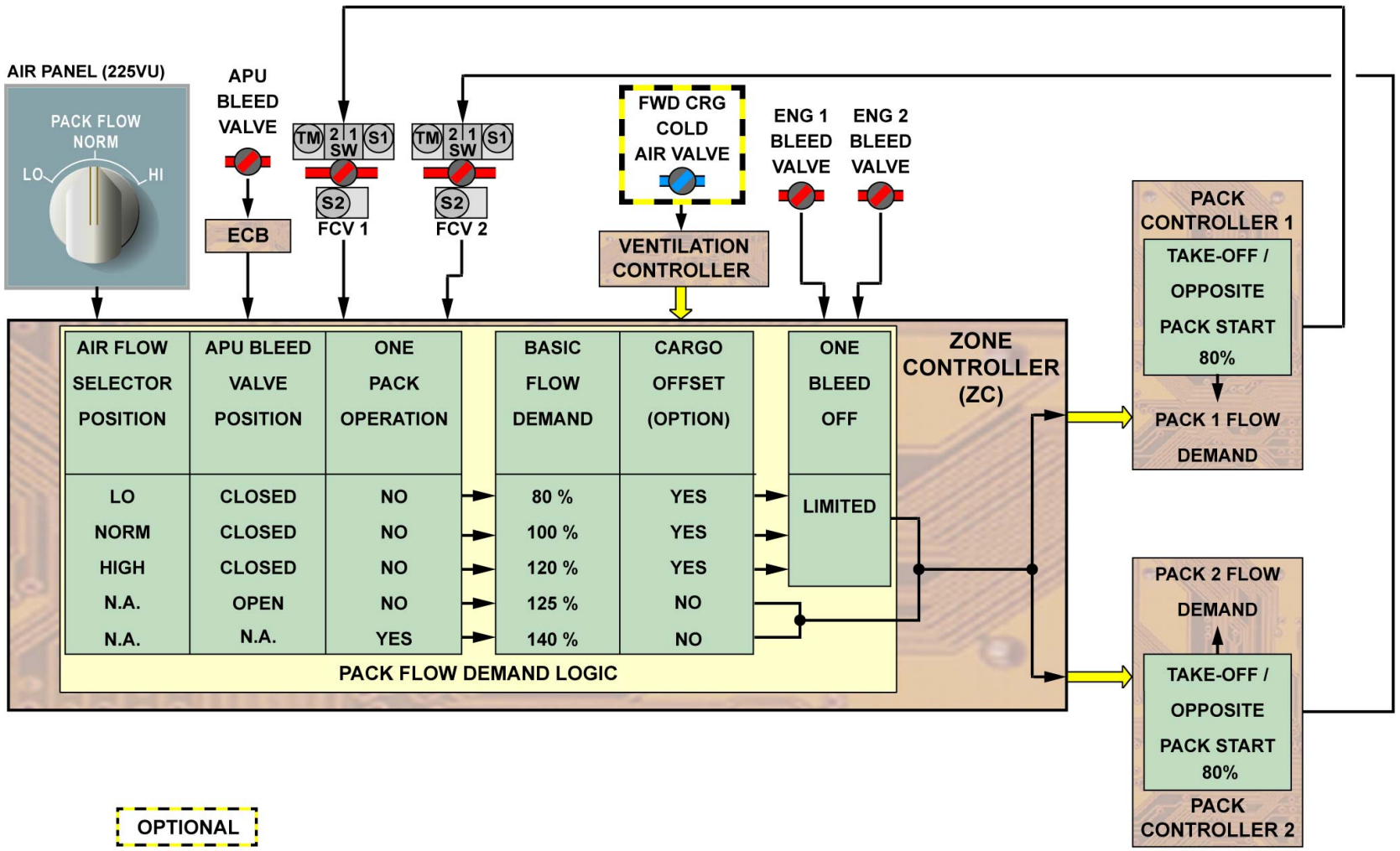
The pack flow demand is set to 123.5% if both packs are operative and the APU bleed valve is open.

FLOW INCREASE REQUEST

The pack flow demand is increased in order to maintain cabin pressurization. The demand comes from the CPCs.

TAKE-OFF/OPPOSITE PACK START

Each PC overrides the pack flow demand received from the ZC to prevent pack compressor overheat. Thus, pack flow demands are set to 80% during take-off or opposite pack starting sequence.



PACK FLOW DEMAND - AIR MANAGEMENT ... TAKE-OFF/OPPOSITE PACK START

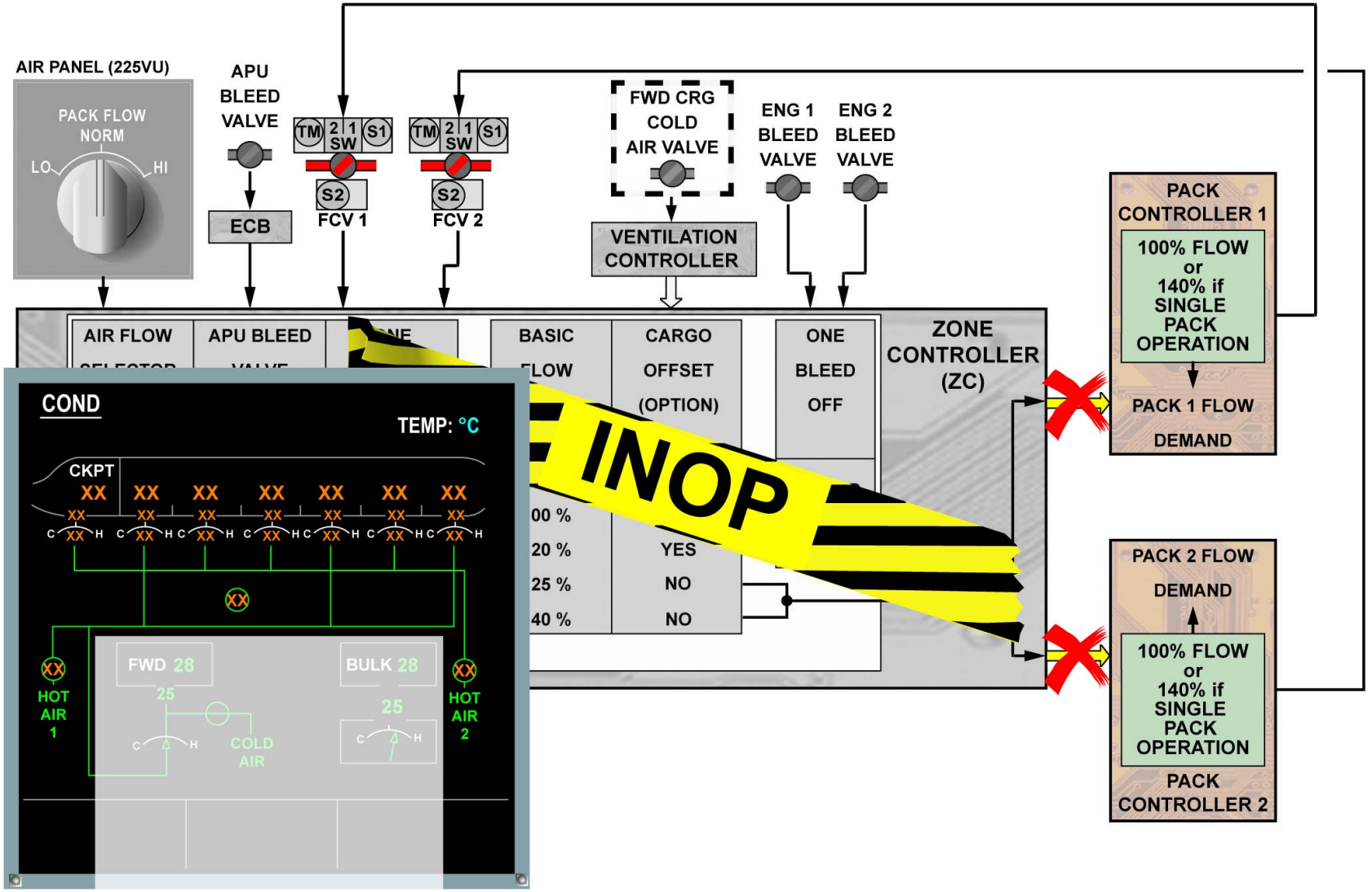
G9409341 - GAUT0T0 - FM21D1AIRFLOW03

PACK AIR FLOW REGULATION D/O (3)

PACK FLOW DEMAND (continued)

ABNORMAL OPERATION: ZONE CONTROLLER FAILURE

In case of zone controller failure, the flow is set to 100% or 140% if single pack operation. The pack outlet temperature is set to 20 deg.C.



PACK FLOW DEMAND - ABNORMAL OPERATION: ZONE CONTROLLER FAILURE

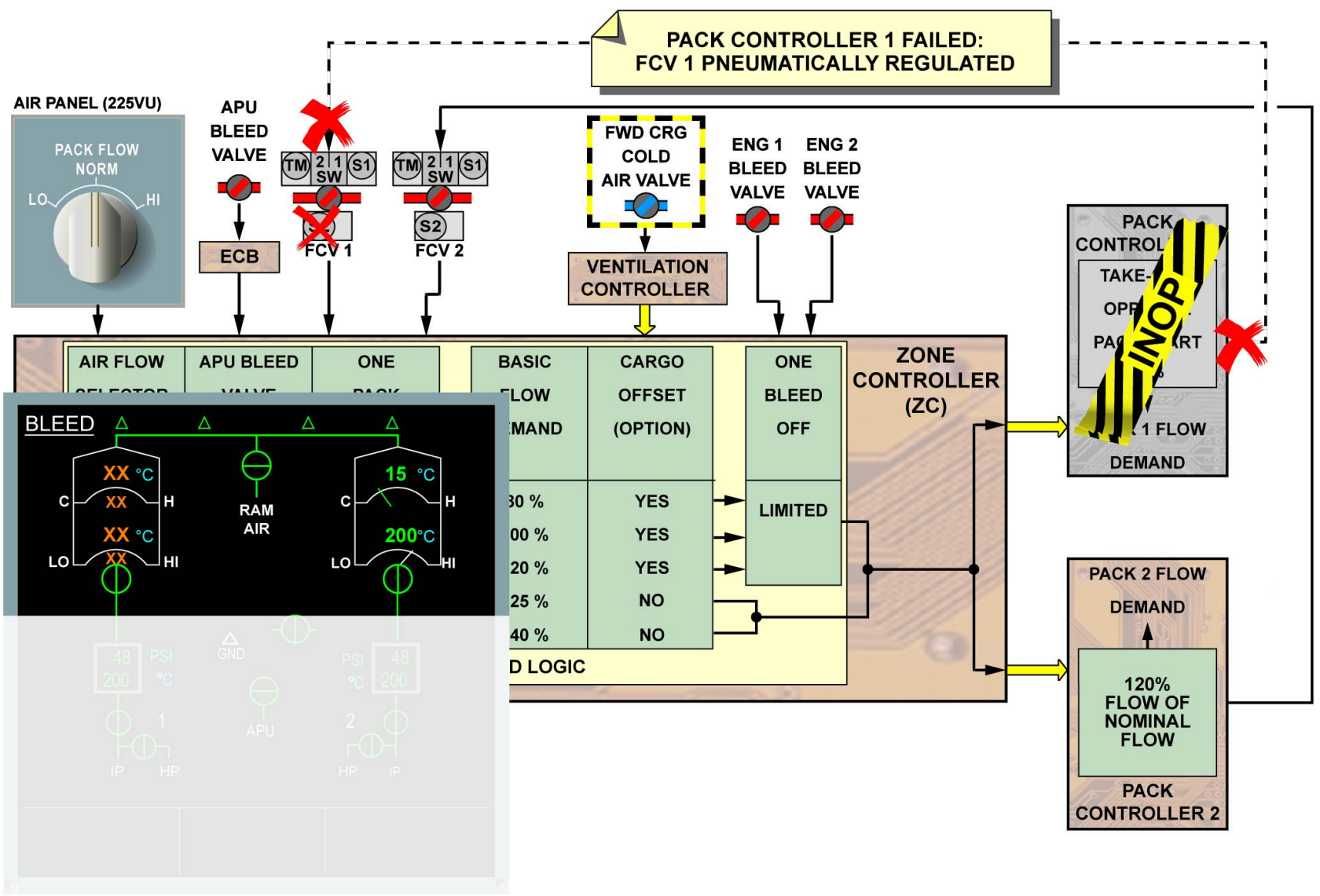
G94093341 - GAUT0T0 - FM21D1AIRFLOW03

PACK AIR FLOW REGULATION D/O (3)

PACK FLOW DEMAND (continued)

ABNORMAL OPERATION: PACK CONTROLLER FAILURE

In case of pack controller failure, the Flow Control Valve operates pneumatically. The flow is set to 120 % of nominal flow



PACK FLOW DEMAND - ABNORMAL OPERATION: PACK CONTROLLER FAILURE

G9409341 - GAUT0T0 - FM21D1AIRFLOW03

PACK TEMPERATURE CONTROL D/O (3)

PACK OVERVIEW PRINCIPLE

A dedicated PC controls the pack air temperature.

SYSTEM ARCHITECTURE

The pack air temperature is controlled by:
- the Temperature Control Valve (TCV) for short-term regulation,
- the RAI and Ram Air Outlet (RAO) flaps for long-term regulation.

The TCV directly modulates the pack discharge temperature by adding hot air to the ACM outlet. The RAI and RAO flaps modulate the ram airflow through the ram air system. Electrical actuators actuate the flaps. During take-off and landing, the RAI flap fully closes to prevent ingestion of foreign matter. An anti-ice valve prevents ice build-up in the water extraction loop. The AIV pneumatically modulates hot bleed air supply to the ACM outlet in case of icing conditions.
In the event of ACM failure, the cooling is performed by the heat exchangers and the pack temperature control is achieved by means of ram air modulation and temperature control valve regulation.

SYSTEM CONTROLS

The PC electrically controls the TCV and the actuators according to:
- the pack temperature demand calculated by the ZC,
- the actual pack temperature.

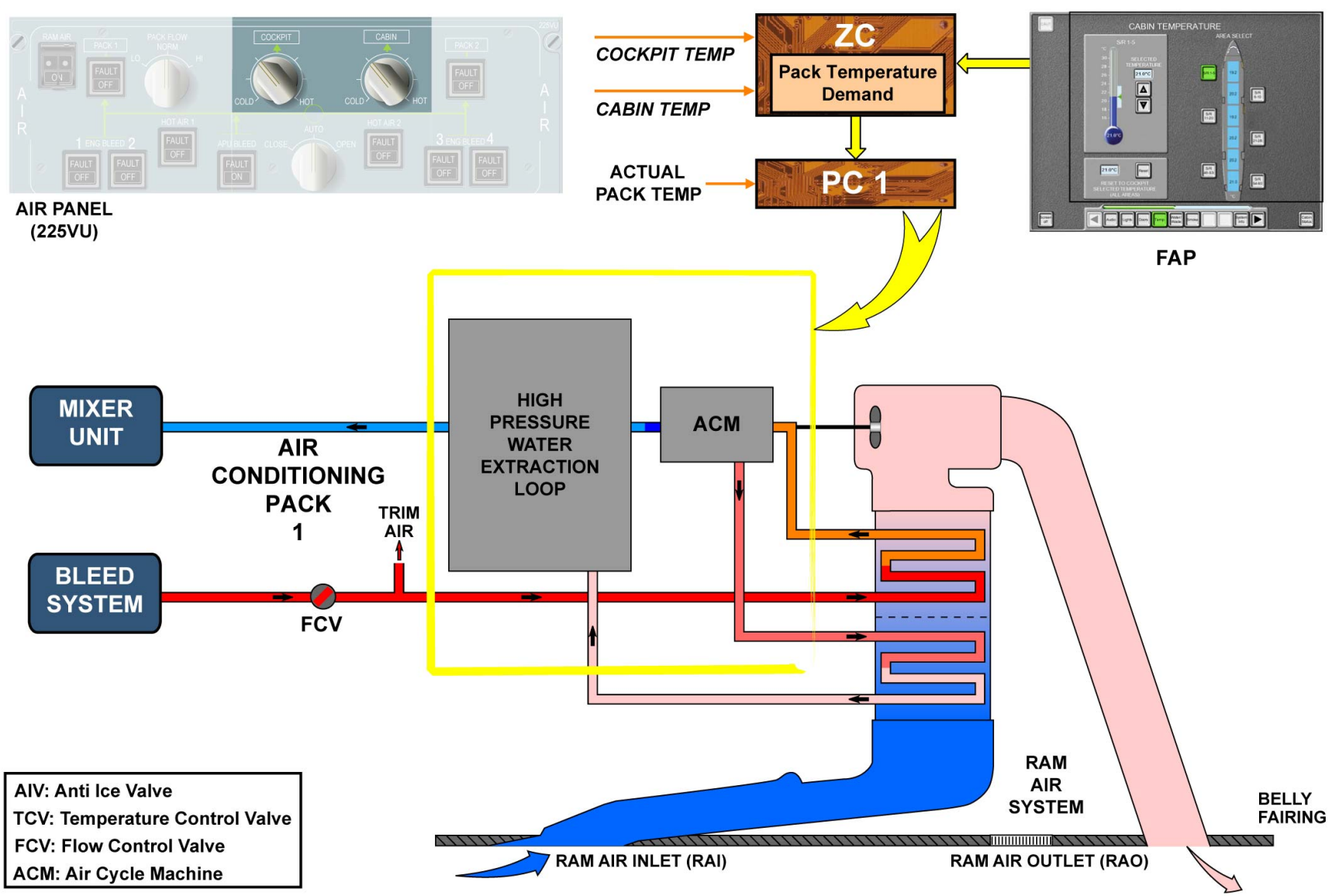
The pack temperature demand calculation depends on the lowest temperature demand based on:
- the temperature selections on the AIR panel,
- the cabin area temperature adjustment on the Flight Attendant Panel (FAP) through the CIDS.

SYSTEM MONITORING

Each PC provides basic temperature and flow regulation of its associated pack. The PC contains two independent computer lanes, each of which is capable of performing all control and monitoring functions. One of these lanes is designated as being "active" while the other lane remains in a passive "hot-standby" mode. An automatic changer over occurs at the end of each flight or during the flight, if there is a failure in the active lane. If a fault occurs in both lane, active control will be passed to the lane with the least significant fault.

PACK CONTROLLER

Each Pack Controller (PC) contains two independent computer lanes, each of which is able to perform all control, monitoring and BITE functions. One of these lanes is designated as being "active" while the other lane remains in a passive "hot-standby" mode. An automatic changeover occurs at the end of each flight or during the flight, if there is a failure in the active lane. Should a fault exist in both lanes, active control will be passed to the lane with the least significant fault. A covered RS232 test equipment connector is fitted to the controller front.



PACK OVERVIEW PRINCIPLE - SYSTEM ARCHITECTURE ... PACK CONTROLLER

G9409341 - GAUT0T0 - FM21D3AIRPCTL03

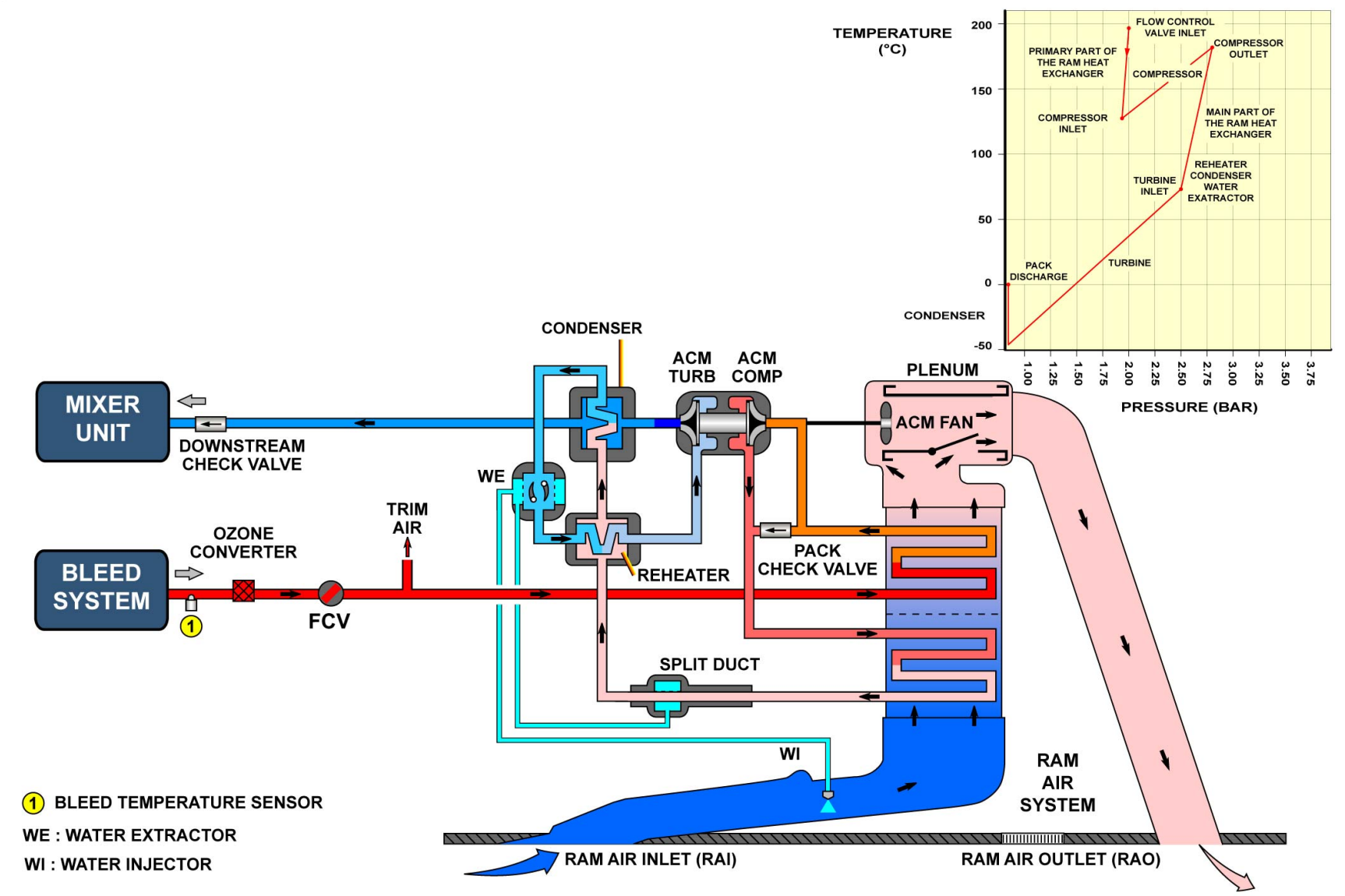
PACK TEMPERATURE CONTROL D/O (3)

SYSTEM DESCRIPTION

The pack temperature regulation system ensures:
- pack discharge temperature regulation,
- ice build-up protection,
- overheat protection,
- main pack parameters monitoring.

PACK COMPONENT D/O: COOLING/WATER EXTRACTION

The air cooling system decreases the temperature of the hot bleed air from the pneumatic system. It also reduces the quantity of water in the hot bleed air.
The water extractors are installed between the condensers and the reheaters. They remove the water that condenses in the condensers. The condensed water and the water from the split duct drains to the applicable water injectors.



SYSTEM DESCRIPTION & PACK COMPONENT D/O: COOLING/WATER EXTRACTION

G9409341 - GAUT0T0 - FM21D3AIRPCTL03

PACK TEMPERATURE CONTROL D/O (3)

PACK COMPONENT D/O: HEATING SYSTEM

AIR INLET/OUTLET FLAP ACTUATORS

Each actuator is mechanically driven by an electrical motor controlled by the pack controller. Each actuator is fitted with:
- 2 potentiometers for actual position feedback,
- 2 limit switches to prevent damage in case of potentiometer failure.

TEMPERATURE CONTROL VALVE

The temperature control valve is a modulating butterfly valve. The temperature control valve is mechanically actuated by a stepper motor and electrically controlled by the pack controller. The temperature control valve is fitted with potentiometers installed at the end of its shaft which send electrical resistance value in relation to the valve position. The lower end of the valve shaft has an indication-mark showing the position of the valve.

ANTI-ICE VALVE

The anti-ice valve is a modulating butterfly valve. The anti-ice valve is pneumatically actuated and:
- pneumatically controlled through high and low pressure delta P servos when operating in the anti-ice mode,
- pneumatically controlled through a pneumatic temperature sensor when operating in the temperature regulation pneumatic mode.

The delta P servos measure the differential pressure across the condenser for high and low pressure airflow paths. The temperature regulation pneumatic mode is enabled by a solenoid that is electrically controlled by the pack controller. There is a manual lever used for observing the butterfly valve position and manually operating it.

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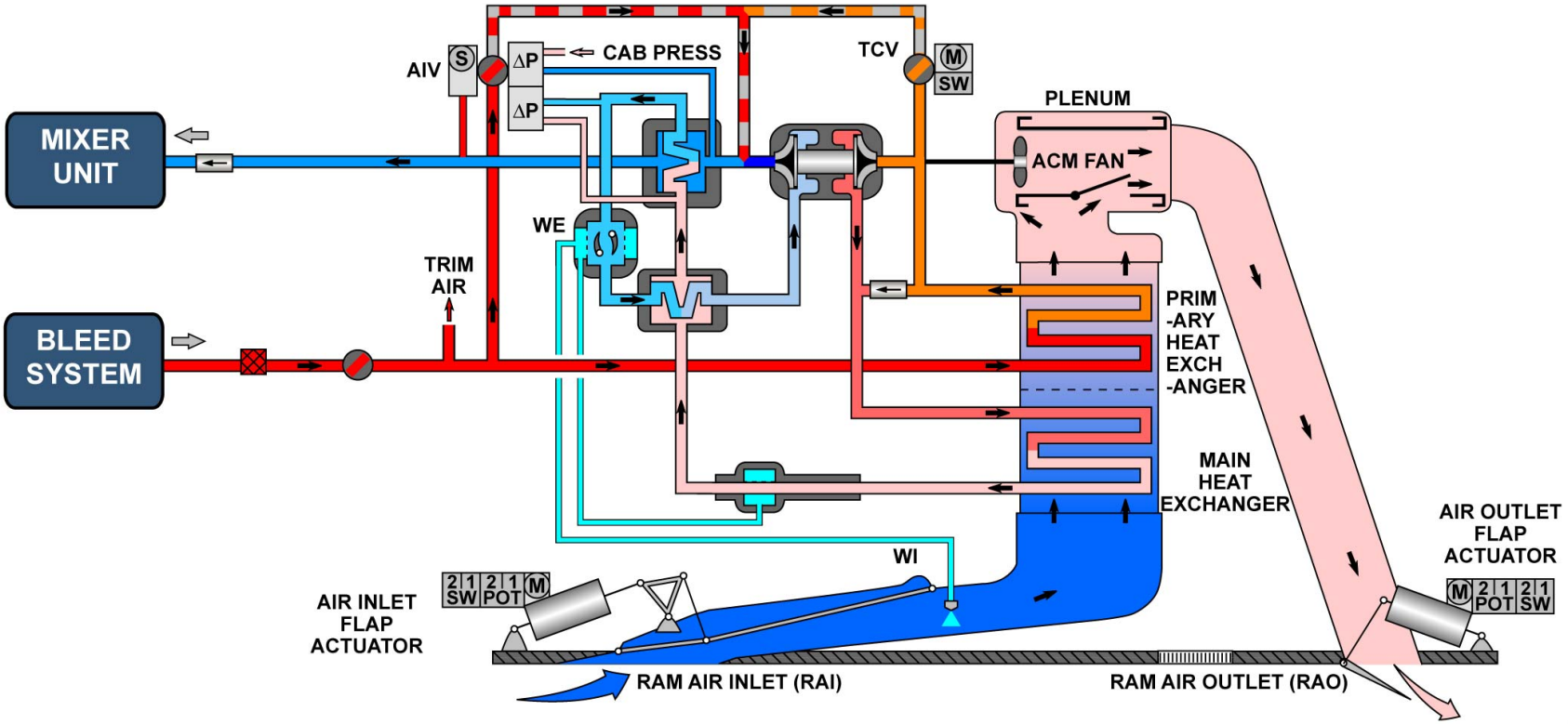


PACK COMPONENT D/O: HEATING SYSTEM - AIR INLET/OUTLET FLAP ACTUATORS ... ANTI-ICE VALVE

G9409341 - GAUT0T0 - FM21D3AIRPCTL03

PACK TEMPERATURE CONTROL D/O (3)

SENSORS

TEMPERATURE SENSORS

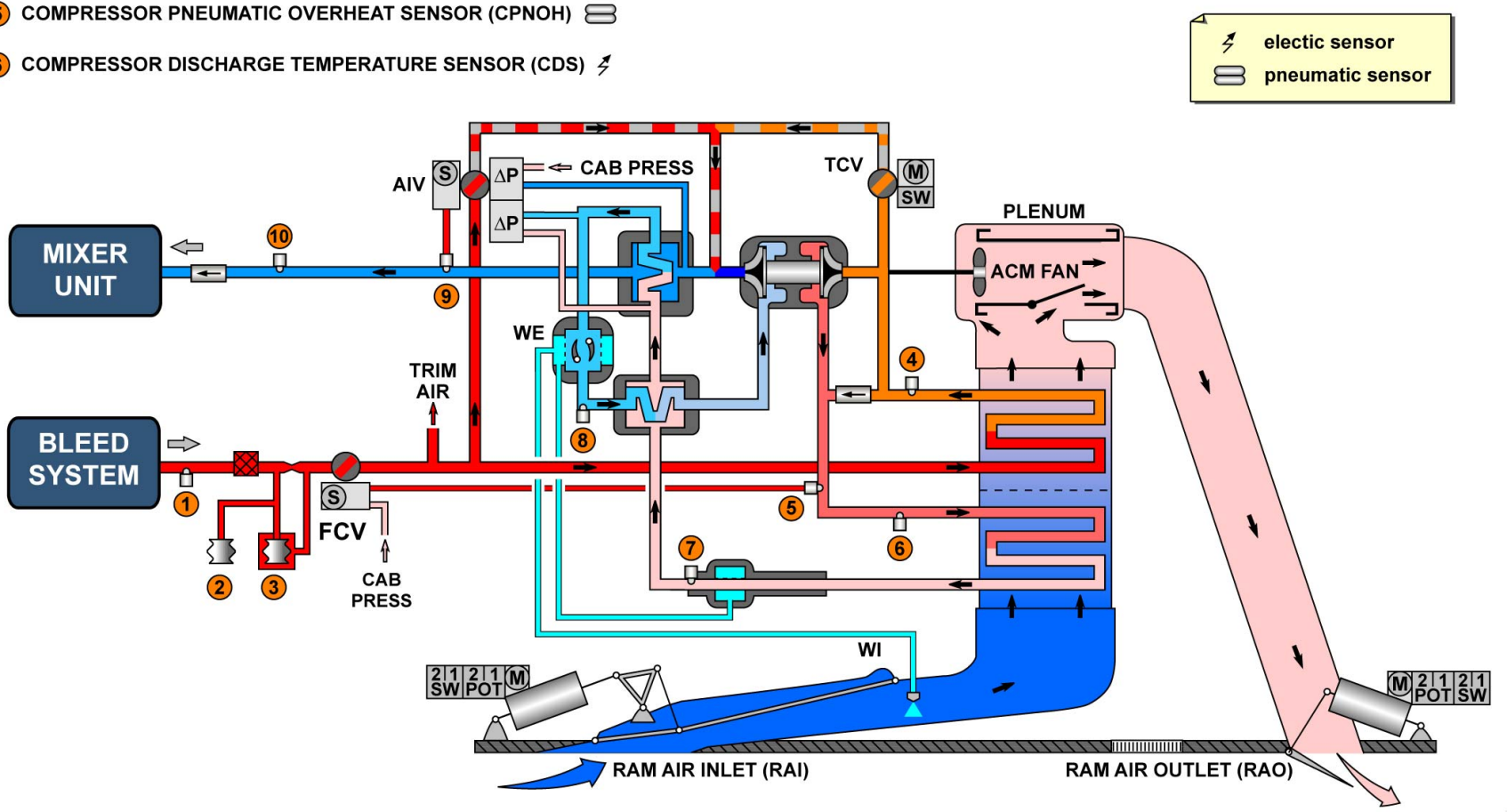
There are five double element sensing thermistor-type temperature sensors installed throughout the pack which provide temperature feedback to the pack controller for temperature control, monitoring and indicating.
The temperature sensors include:
- a compressor inlet temperature sensor located upstream from the compressor (4),
- a compressor discharge temperature sensor located downstream from the compressor (6),
- a heat exchanger temperature sensor located near the split duct (7),
- a pack temperature sensor located near the water extractor (8),
- a pack discharge temperature sensor located downstream from the turbine (10).

PNEUMATIC SENSORS

There are two pneumatic sensors of clapper type. A pneumatic compressor overheat sensor (5) is installed at the compressor outlet and it is connected to the Flow Control Valve (FCV). It controls the FCV to protect the pack in case of compressor outlet overheat. The pneumatic temperature sensor (9) installed at the pack outlet is connected to the anti-ice valve. It controls the anti-ice valve to regulate the pack discharge temperature in case of normal temperature regulation failure.

G9409341 - GAUT0T0 - FM21D3AIRPCTL03

1. BLEED TEMPERATURE SENSOR (BTS)
2. PACK INLET PRESSURE SENSOR (PIPS)
3. FLOW SENSOR
4. COMPRESSOR INLET TEMPERATURE SENSOR (CIS)
5. COMPRESSOR PNEUMATIC OVERHEAT SENSOR (CPNOH)
6. COMPRESSOR DISCHARGE TEMPERATURE SENSOR (CDS)
7. HEAT EXCHANGER TEMPERATURE SENSOR (HOS)
8. PACK TEMPERATURE SENSOR (PTS)
9. PNEUMATIC TEMPERATURE SENSOR (PNTS)
10. PACK DISCHARGE TEMPERATURE SENSOR (PDS)



SENSORS - TEMPERATURE SENSORS & PNEUMATIC SENSORS

G9409341 - GAUT0T0 - FM21D3AIRPCTL03

PACK TEMPERATURE CONTROL D/O (3)

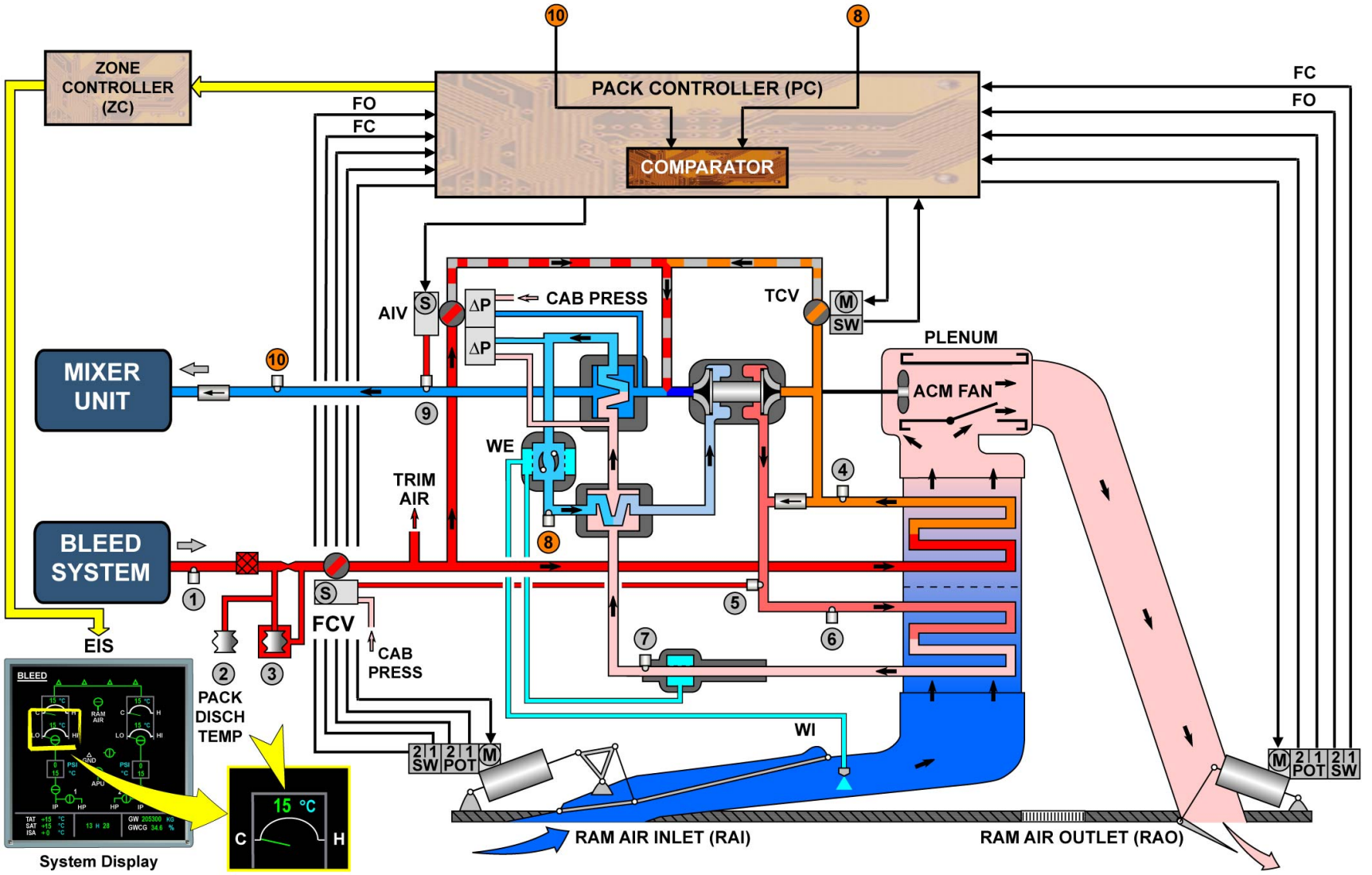
PACK TEMPERATURE REGULATION: NORMAL MODE

The normal mode is based on the pack temperature demand, which corresponds to the lowest zone temperature demand. The pack temperature demand is computed by the zone controller and limited to a low value by the pack controller. The low value depends on the aircraft altitude.
To prevent ice formation in the High Pressure (HP) section of the pack, the temperature is kept above freezing until humidity no longer exists in the bleed air.
The pack controller sets the pack temperature demand to 20°C as default value, if there is no demand signal sent by the zone controller. The limited pack temperature demand is then compared to the actual temperature measured by the pack temperature sensor (8) or, if failed, by the pack discharge temperature sensor (10).The pack discharge temperature data is transmitted to the EIS through the zone controller and displayed on the ECAM BLEED page.
The temperature error signal is processed through a temperature control valve control logic and used to:
- control the temperature control valve stepper motor,
- calculate the temperature control valve actual position.

The temperature control valve actual position determination is based on a step counting principle, after a self-adjustment during a power-up test.
The temperature regulation through the temperature control valve is used for short-term regulation. For long-term regulation, the ram air doors slowly take over from the temperature control valve by modulating the ram airflow while the temperature control valve is driven back to an optimized position. This enables the system to:
- satisfy pack flow requirements, and
- minimize ram air drag.

Under normal conditions, the air outlet flap actuator control is based on the temperature control valve control signal. The air inlet flap actuator is slaved to the actual air outlet flap actuator position. Potentiometers are used to get actual position feedback. Under specific aircraft operating phases, fixed ram air door position signals are used as reference signals.

G9409341 - GAUT0T0 - FM21D3AIRPCTL03



PACK TEMPERATURE REGULATION: NORMAL MODE

G9409341 - GAUT0T0 - FM21D3AIRPCTL03

PACK TEMPERATURE CONTROL D/O (3)

ABNORMAL/DEGRADED OPERATION

The pack control system is able to:
- prevent ice build-up in condenser,
- prevent compressor overheat,
- detect compressor overheat,
- detect pack discharge overheat.

CONDENSER ICE BUILD-UP PREVENTION

If there is ice build-up in the condenser, the differential pressure sensed across it increases proportionally. The anti-ice valve delta P servos open the Anti-Ice Valve. Hot air supplied to the turbine outlet melts the ice in the condenser and causes the differential pressure sensed across the condenser to decrease. The anti-ice function is also operative during the temperature regulation pneumatic back-up mode.

PACK OVERHEAT (ACM COMPRESSOR OVERHEAT PROTECTION)

COMPRESSOR OVERHEAT PREVENTION

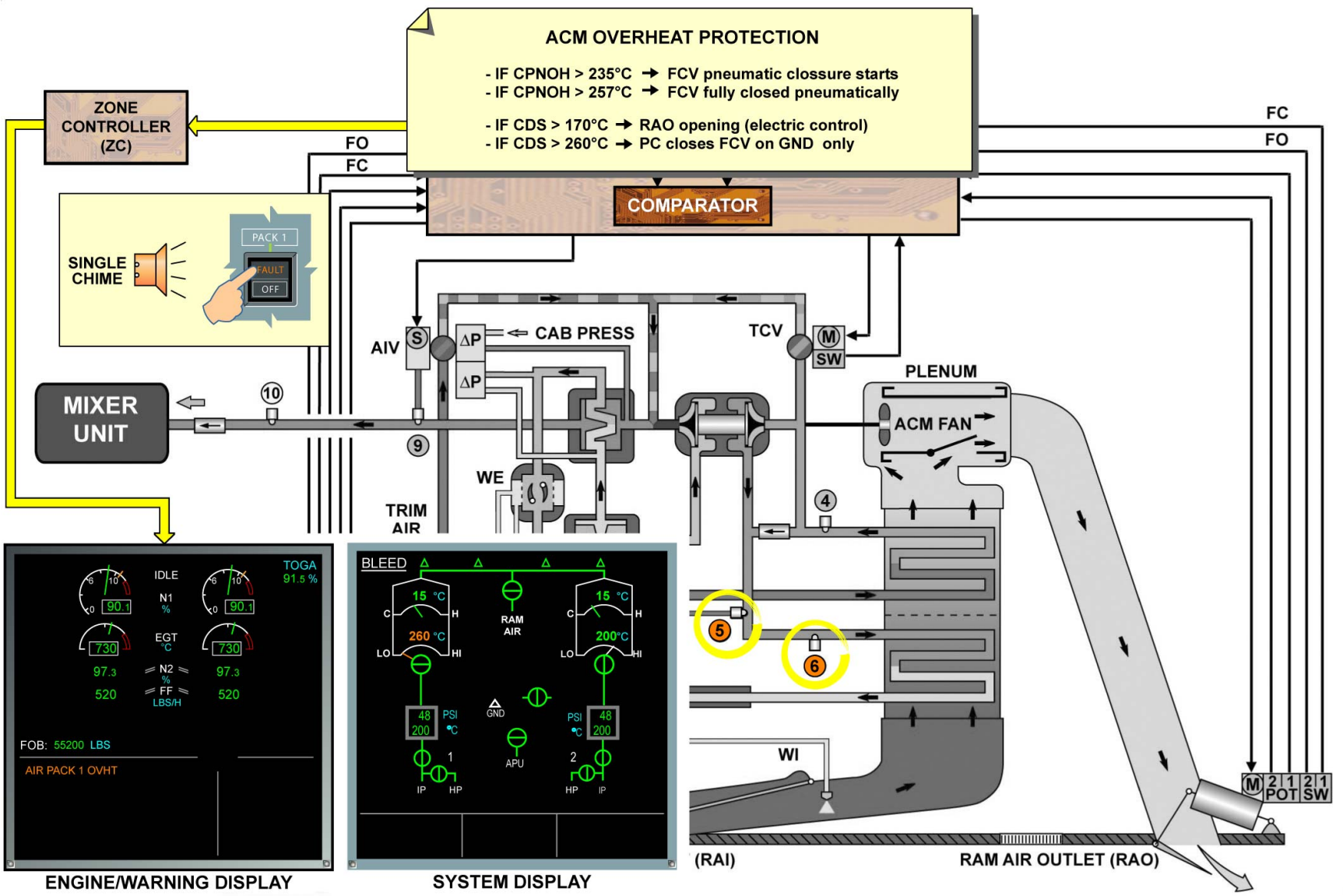
The pack controller continuously monitors high temperatures in the vicinity of the compressor through:
- the compressor discharge temperature sensor (6),and
- the compressor inlet temperature sensor (4) if the compressor discharge temperature sensor (6) is inoperative.

Either of these temperatures is displayed on the ECAM BLEED page.
To prevent compressor overheat, the pack controller processes a signal via a compressor overheat regulator as soon as the compressor discharge temperature rises above 170°C. This signal overrides the normal temperature regulation and drives the ram air doors to a more open position. This increases the ram airflow passing through the ram heat exchanger and the compressor discharge temperature is decreased.
If the overheat condition persists, the pneumatic compressor overheat sensor (5) protects the pack by progressively closing the FCV. The FCV starts to close at 235°C and it is fully closed at 260°C.

COMPRESSOR OVERHEAT DETECTION

The pack controller will automatically close the FCV on ground, if the compressor discharge temperature (6) rises above 260°C. A compressor overheat condition will also trigger:
- a FAULT light on the associated PACK P/BSW,
- an ECAM warning message on the EWD,
- an amber compressor discharge temperature indication on the ECAM BLEED page.

In flight, the crew will be requested to manually set the associated PACK P/BSW to OFF. The FAULT light will disappear as soon as:
- the related FCV is fully closed, and
- the compressor discharge temperature drops below 180°C.



ABNORMAL/DEGRADED OPERATION & PACK OVERHEAT (ACM COMPRESSOR OVERHEAT PROTECTION)

G9409341 - GAUT0T0 - FM21D3AIRPCTL03

PACK TEMPERATURE CONTROL D/O (3)

PACK OVERHEAT (PACK DISCHARGE)

PACK DISCHARGE OVERHEAT DETECTION

A pack discharge overheat condition is set as soon as the pack discharge temperature (10) rises above 95°C.
It will trigger:
- a FAULT light on the associated PACK P/BSW,
- an ECAM warning message on the EWD,
- an amber pack discharge temperature indication on the ECAM BLEED page.

The crew will be requested to manually set the associated PACK P/BSW to OFF. The FAULT light will disappear as soon as:
- the related FCV is fully closed, and
- the pack discharge temperature drops below 60°C.

PACK OVERHEAT PROTECTION ON GROUND

On ground only, the PCs ensure packs overheat protection in case the packs are running without any crew in the cockpit. The PC closes the associated FCV if the following conditions occur:
- compressor overheat or pack discharge overheat, and
- no FCV electrical closure command, and
- aircraft is on ground .

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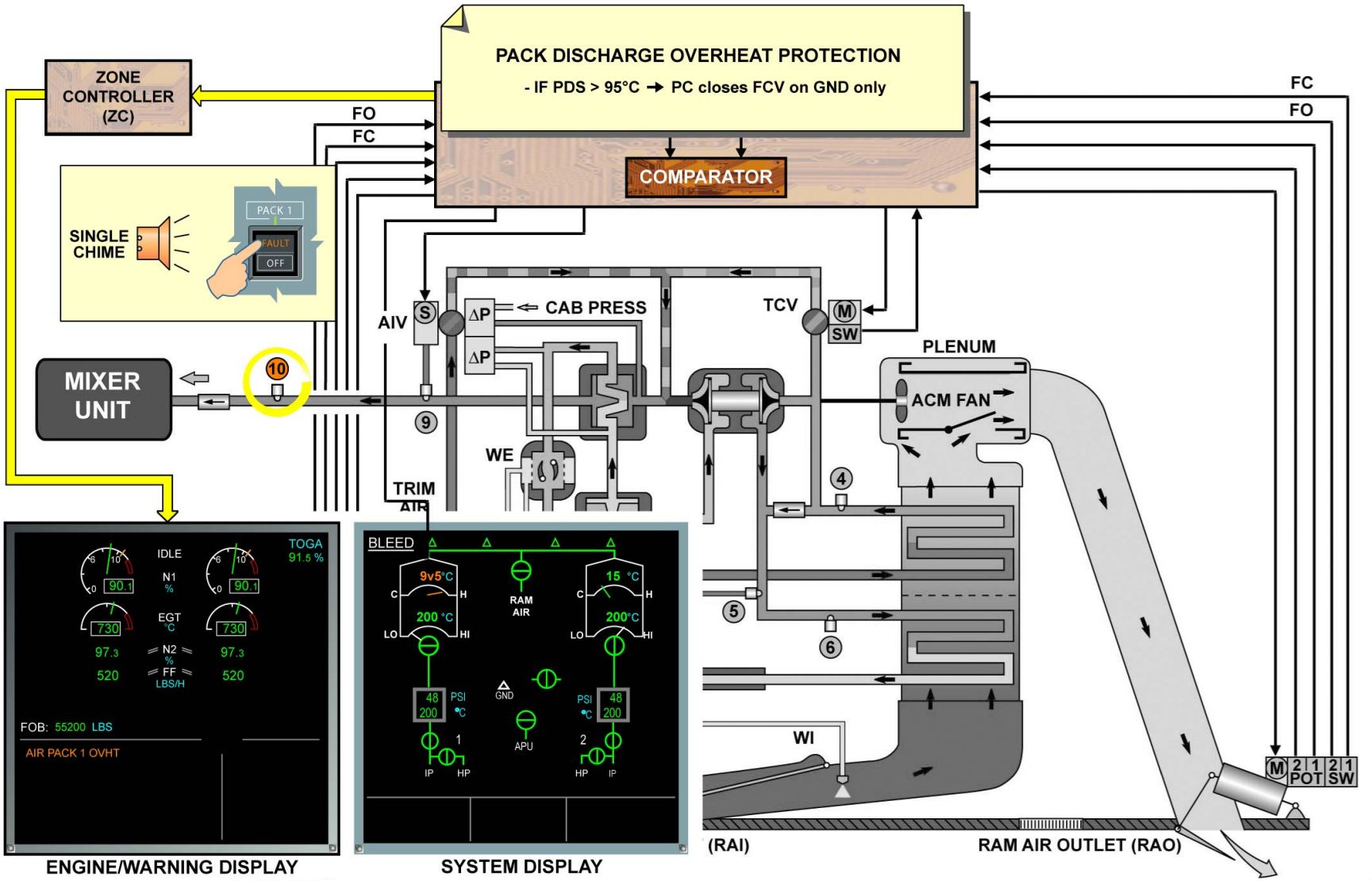


PACK OVERHEAT (PACK DISCHARGE) - PACK DISCHARGE OVERHEAT DETECTION & PACK OVERHEAT PROTECTION ON GROUND

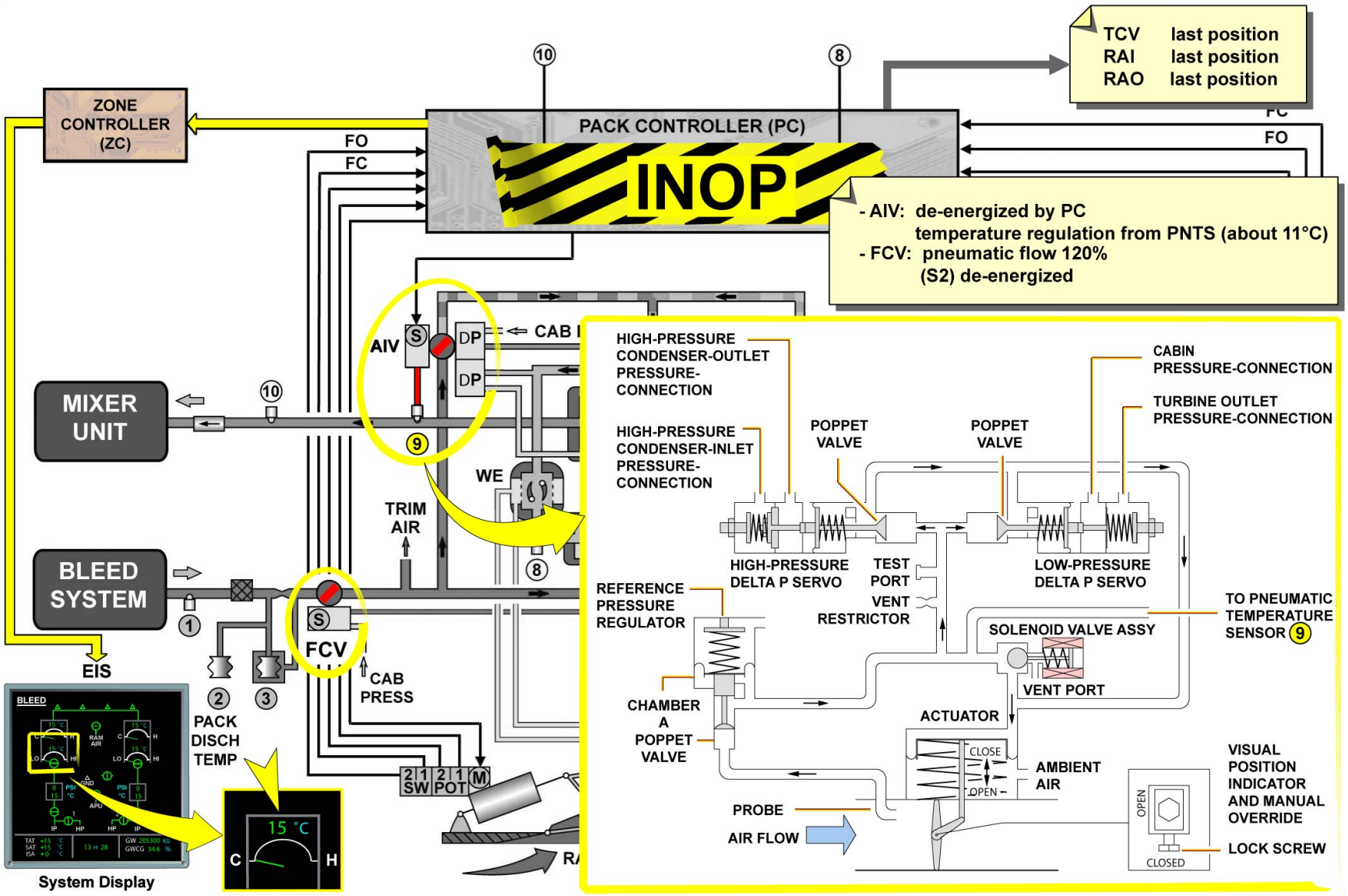
G9409341 - GAUT0T0 - FM21D3AIRPCTL03

PACK TEMPERATURE CONTROL D/O (3)

PACK PNEUMATIC MODE

The pneumatic back-up mode operates if there is:
- a pack controller failure,
- a pack controller power supply loss,
- a temperature control valve failure.

When the anti-ice valve solenoid is de-energized. The pneumatic temperature sensor (9) modulates the anti-ice valve position in order to control the pack discharge temperature to approximately 11°C. The ram air doors are set to fixed positions depending on the failure.



PACK PNEUMATIC MODE

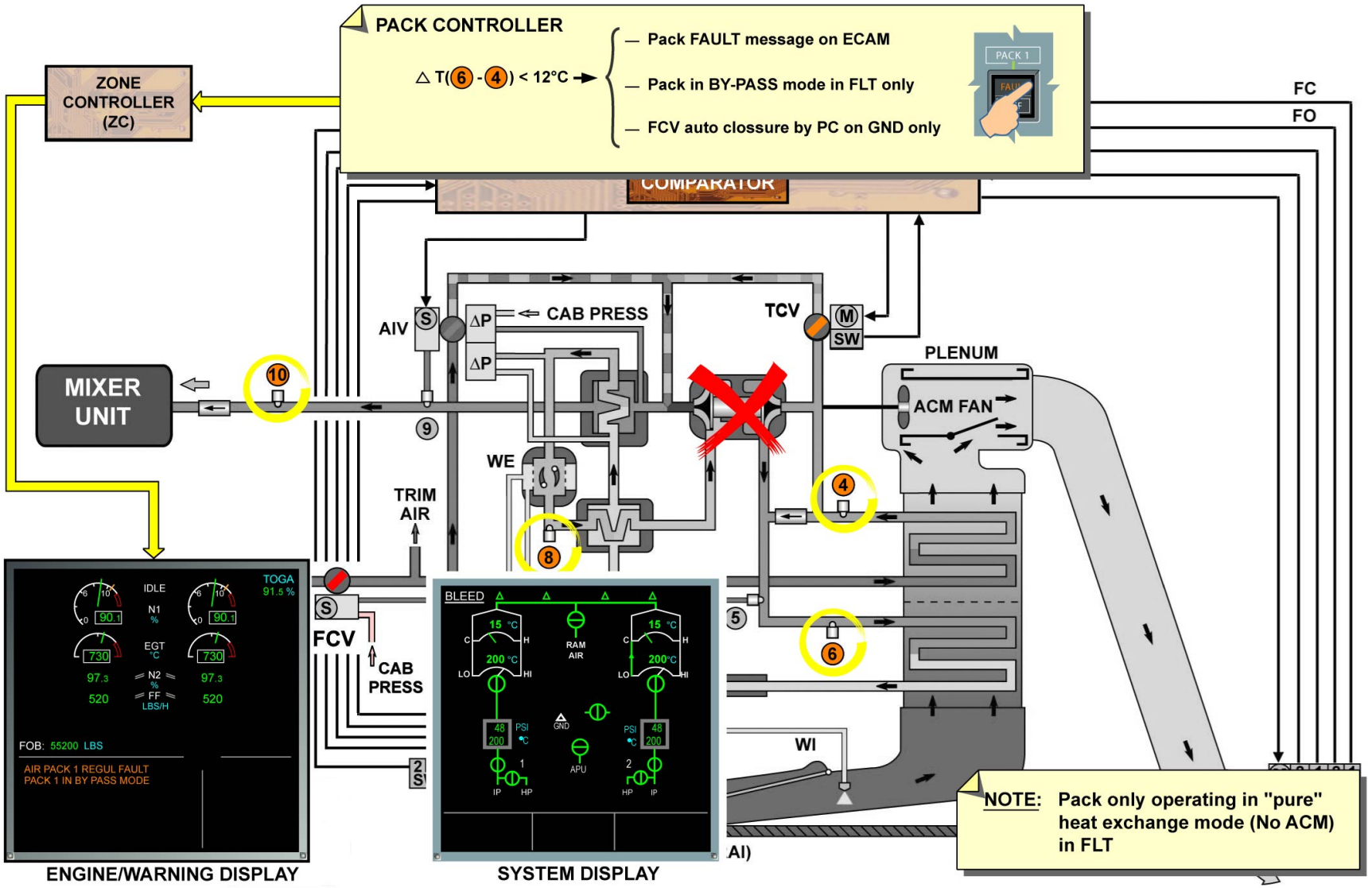
G9409341 - GAUT0T0 - FM21D3AIRPCTL03

PACK TEMPERATURE CONTROL D/O (3)

ACM SEIZURE (PACK IN BYPASS MODE)

An air cycle machine seizure is detected when the temperature difference between the Compressor inlet temperature sensor (4) and the Compressor discharge temperature sensor (6) is less than 12deg. The pack operates in pure heat exchanger mode, the HP water extraction loop is operative but it has a limited effect on the water extraction process. The normal pack temperature regulation is kept, however it is only based on the use of the pack discharge temperature sensor (10) instead of the pack temperature sensor (8). When the pack operates in heat exchanger mode, ram air door closure is not accomplished during landing phase. Due to the air cycle machine design, air passes through the air cycle machine and water extraction loop as in normal operation. The compressor is bypassed through the pack check valve only if there is not enough bleed air pressure. The air cycle machine seizure status is transmitted to the EIS through the zone controller and displayed on the ECAM BLEED page.

G9409341 - GAUT0T0 - FM21D3AIRPCTL03



ACM SEIZURE (PACK IN BYPASS MODE)

G9409341 - GAUT0T0 - FM21D3AIRPCTL03

PACK TEMPERATURE CONTROL D/O (3)

PACK HEAT EXCHANGER CONTAMINATION (ABNORMAL)

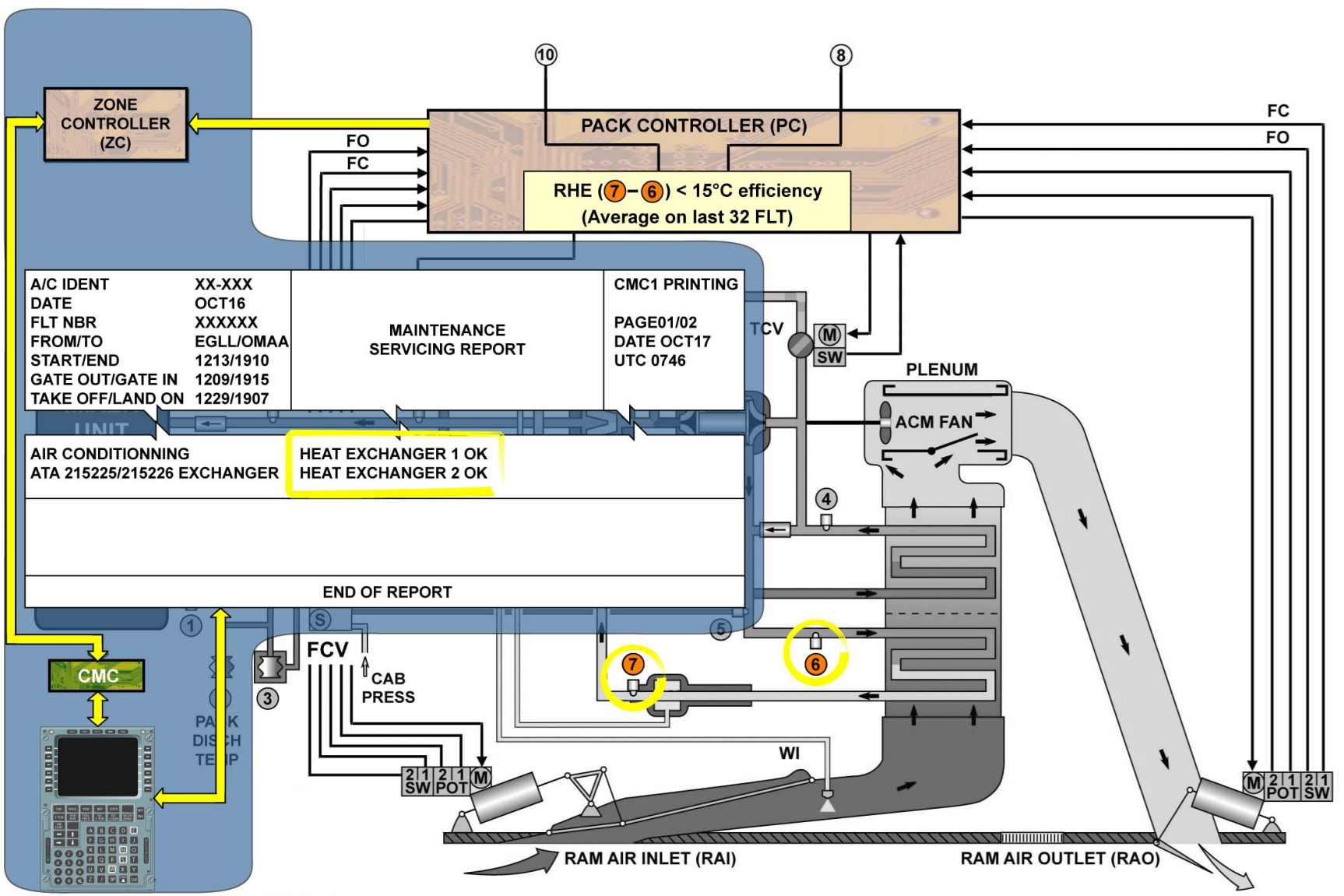
Although the ram heat exchanger is designed to minimize contamination, a long-term ingestion of dust could lead to a pack performance loss. Thus, the ram heat exchanger is automatically trend-monitored in order to detect a start of contamination. In order to start the trend monitoring, the pack controller checks the prerequisite conditions. The aircraft must be on ground with the APU and the pack ON. If the conditions are fulfilled, the pack controller checks the stability of the following data:
- the bleed temperature (1),
- the Total Air Temperature (TAT),
- the pack inlet pressure (2),
- the heat exchanger temperature (7).

The data is recorded once it is stabilized and the trend monitoring will accomplished. The outlet temperature of the main part of the Ram Heat Exchanger (RHE) is extrapolated with the bleed temperature, the TAT and the pack inlet pressure, and compared to the actual heat exchanger temperature.

The pack controller stores the temperature error (delta T) and associated flight leg data in its Electrically Eraseable Programmable Read Only Memory (EEPROM) as soon as a new flight leg starts. The memory has a storage capacity of up to 65 flight legs and can be reset from a Central Maintenance System (CMS) menu page though the zone controller.

A new average temperature error is then calculated with the last 32 flight legs. The pack controller triggers a message on the CMS if the average value rises above 15°C.

G9409341 - GAUT0T0 - FM21D3AIRPCTL03



PACK HEAT EXCHANGER CONTAMINATION (ABNORMAL)

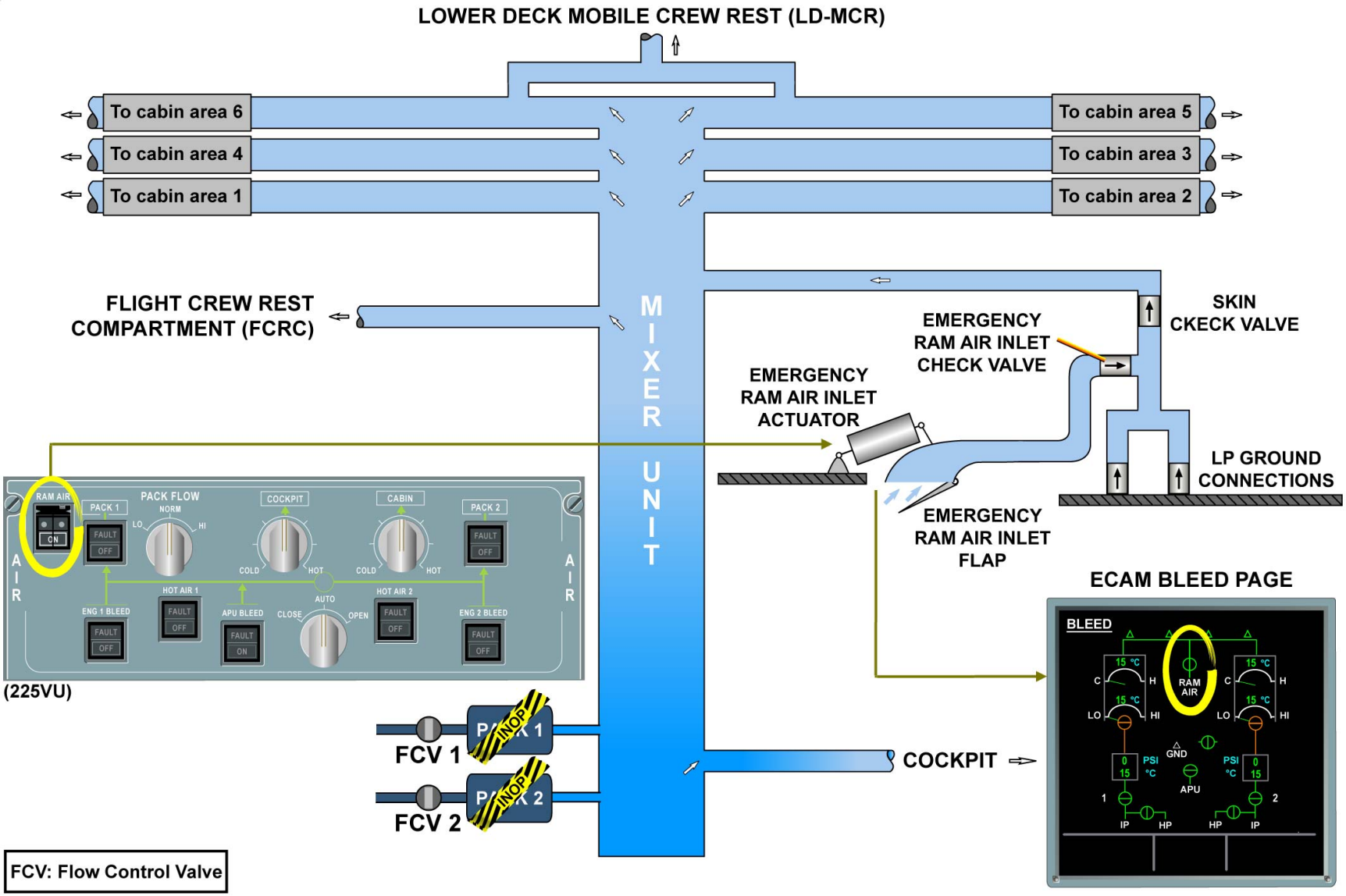
G9409341 - GAUT0T0 - FM21D3AIRPCTL03

EMERGENCY RAM AIR INLET D/O (3)

GENERAL

The A/C is equipped with one emergency ram air inlet flap located at the lower left-hand belly fairing of the fuselage. It shares the same duct as the low pressure ground connections.

G9409341 - GAUT0T0 - FM21D4F21TL0102


LOWER DECK MOBILE CREW REST (LD-MCR)
To cabin area 6
To cabin area 4
To cabin area 1
To cabin area 5
To cabin area 3
To cabin area 2
FLIGHT CREW REST COMPARTMENT (FCRC)
MIXER UNIT
SKIN CKECK VALVE
EMERGENCY RAM AIR INLET CHECK VALVE
EMERGENCY RAM AIR INLET ACTUATOR
LP GROUND CONNECTIONS
EMERGENCY RAM AIR INLET FLAP
ECAM BLEED PAGE
RAM AIR
PACK 1
PACK FLOW
NORM
LO
HI
COCKPIT
CABIN
PACK 2
FAULT
OFF
ON
COLD
HOT
AIR
HOT AIR 1
HOT AIR 2
ENG 1 BLEED
APU BLEED
CLOSE
AUTO
OPEN
ENG 2 BLEED
(225VU)
FCV 1
FCV 2
INOP
COCKPIT
BLEED
15 °C
C
H
LO
HI
GND
APU
PSI
°C
IP
HP
1
2
FCV: Flow Control Valve

GENERAL

EMERGENCY RAM AIR INLET D/O (3)

OPERATION

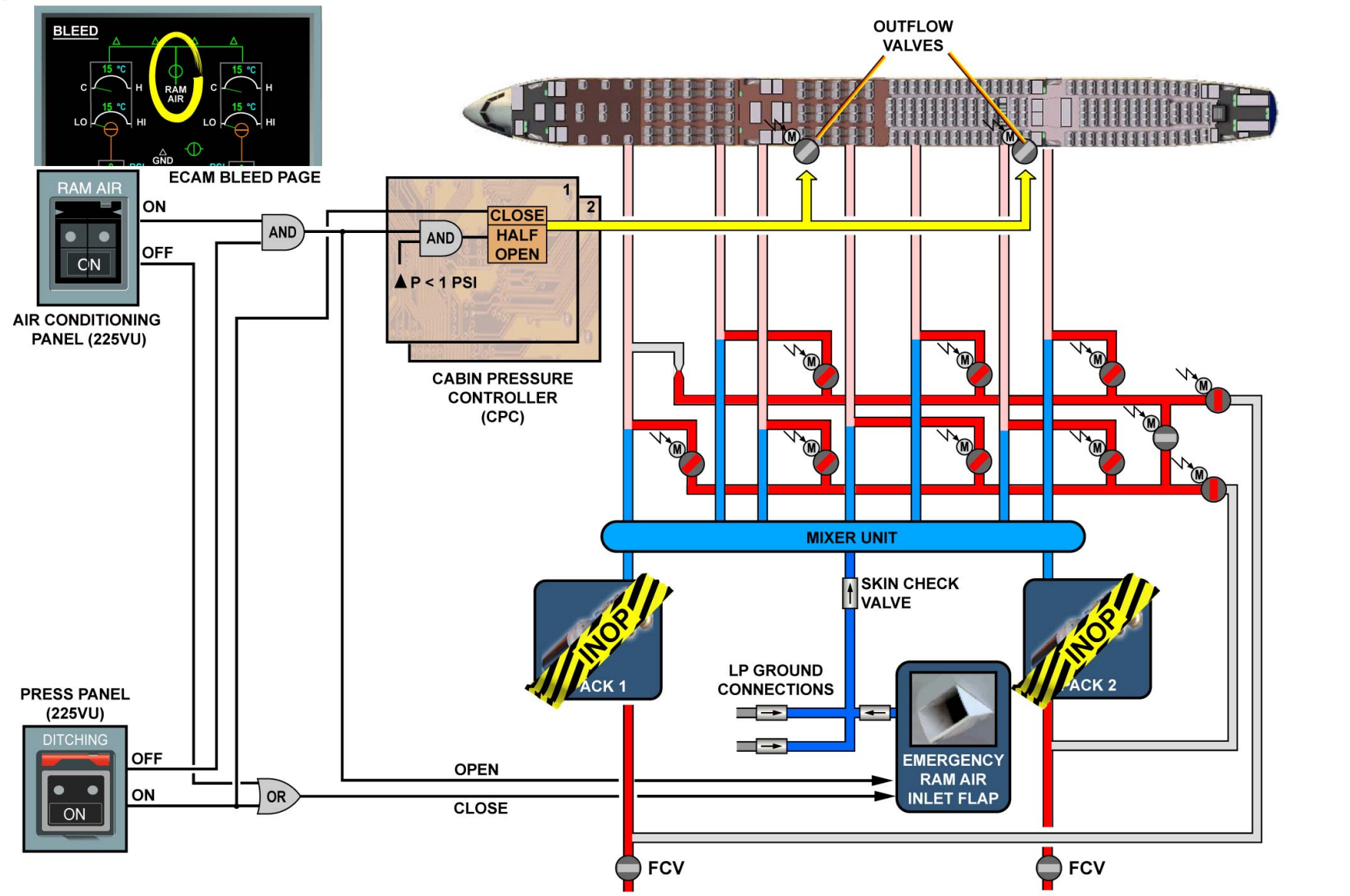
The emergency ram air inlet flap can be opened for A/C ventilation in case of complete loss of the operation of the two air conditioning packs.

OPENING

To open the emergency ram air inlet, lift the guard and set the ram air pushbutton switch to ON. If ditching is not selected ON, a signal is sent to the emergency ram air inlet actuator and the emergency ram air inlet allows the external airflow to enter.
A signal is also sent to the Cabin Pressure Controller (CPC) and if the altitude of the A/C is less than 10.000 ft and the difference of pressure between the pressure in the fuselage and the external pressure (P) is less than 1 PSI, the outflow valves open half way.

CLOSING

To close the emergency ram air inlet lift the guard and select the ram air pushbutton off. The outflow valves close as necessary to maintain cabin pressurization. Another signal is sent to the emergency ram air inlet actuator and the emergency ram air inlet closes.
The emergency ram air inlet closes automatically when the DITCHING pushbutton is set to ON.



OPERATION - OPENING & CLOSING

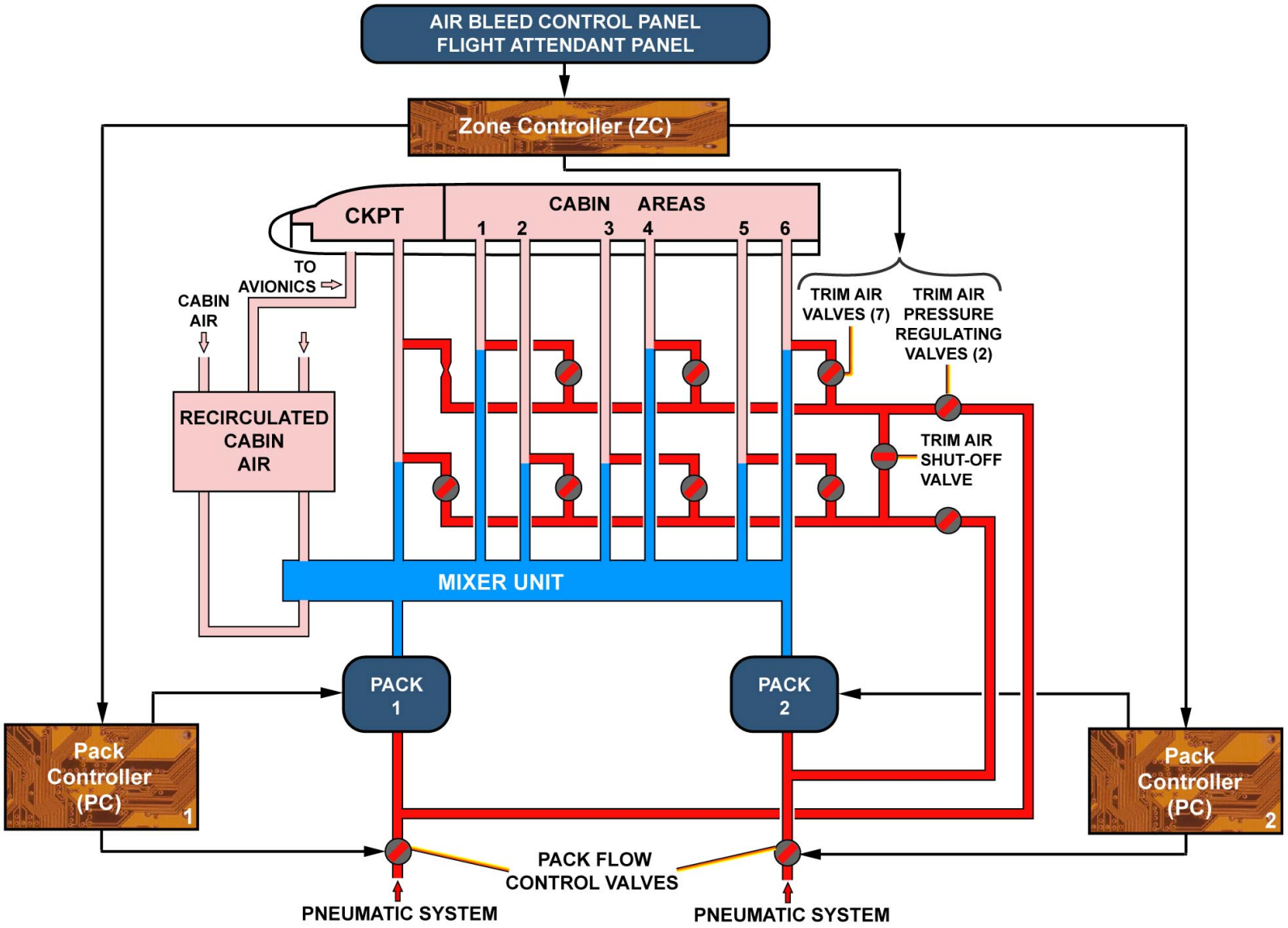
G9409341 - GAUT0T0 - FM21D4F21TL0102

COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

SYSTEM DESCRIPTION

The system does the:
- cockpit/cabin temperature control and monitoring,
- zone component monitoring,
- abnormal/degraded operation handling,
- calculation of demands to other A/C systems.

G9409341 - GAUT0T0 - FM21D5AIRCCTL03



SYSTEM DESCRIPTION

G9409341 - GAUT0T0 - FM21D5AIRCCTL03

COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

SYSTEM DESCRIPTION (continued)

ZONE CONTROLLER

The Zone Controller (ZC) contains two independent computer lanes, each of which is able to do all control, monitoring and BITE functions. One lane is designated as being "active" while the other lane remains in a passive "hot-standby" mode. An automatic changeover occurs at the end of each flight or during the flight, if there is a failure in the active lane. If a fault exists in both lanes, active control will be sent to the lane with the least significant fault. The ZC provisions are defined through pin programming.

TRIM AIR PRESSURE REGULATING VALVES (TAPRVs)

Two Trim Air Pressure Regulating Valves (TAPRVs), and each valve is a pressure regulating and shut-off butterfly valve. There is one TAPRV per trim air system. Each valve has:
- a pneumatic actuator, spring-loaded closed,
- a solenoid for the shut-off function,
- a double limit switch for Fully Closed (FC) / Not Fully Closed (NFC) position detection.

The valve is failsafe closed. A manual lever shows the valve position and makes manual overriding possible.

TRIM AIR SHUT-OFF VALVE (TASOV)

The Trim Air Shut-Off Valve is a shut-off butterfly valve. It is mechanically actuated by a 28V DC motor and electrically controlled from the ZC. The valve has two positions and has two limit switches for FC / Fully Open (FO) position detection. The valve has a thermal overheat protection. A manual lever shows the valve position and makes manual overriding possible.

TRIM AIR VALVES (TAVs)

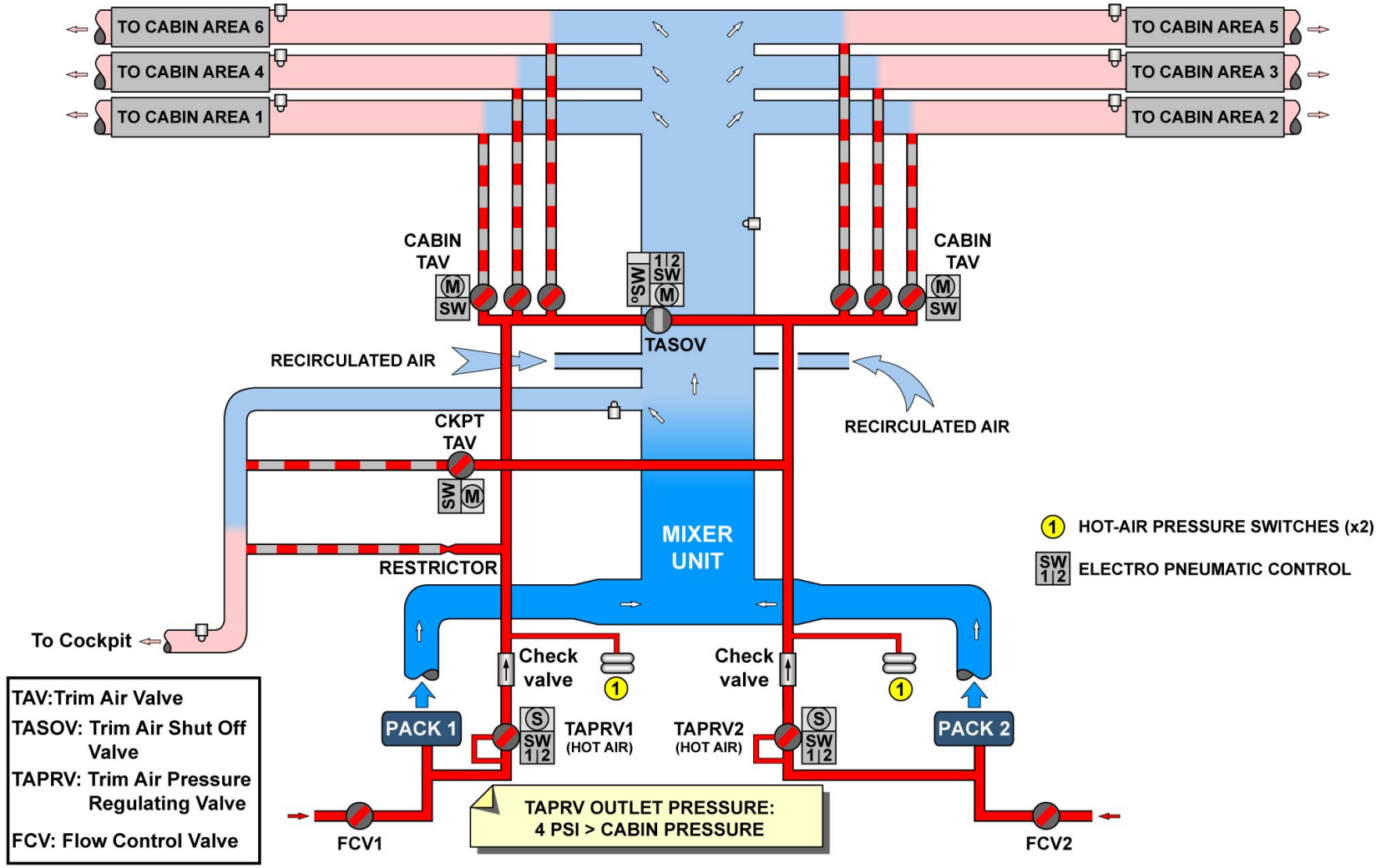
The Trim Air Valves (TAVs) are modulating butterfly valves. There is one trim air valve per each of the 6 cabin areas and one for the cockpit. All valves are interchangeable. Each valve is mechanically actuated by a stepper motor and electrically controlled from the ZC. The trim air valve has a limit switch for FC / NFC position detection. A manual lever shows the valve position and makes manual overriding possible.

HOT AIR PRESSURE SWITCHES

There is one hot air pressure switch (1) per trim air system. It has a diaphragm, a disk spring and a microswitch. The two hot air pressure switches are interchangeable.

MIXER UNIT/DUCT TEMPERATURE SENSORS

There is one duct temperature sensor per each of the 6 cabin areas and one for the cockpit (3). They give duct temperature feedback to the ZC for duct temperature control, monitoring and indicating. There is also one temperature sensor installed on the mixer unit (2). It gives a mixer unit temperature feedback to the ZC for pack temperature demand calculation. All sensors are double element-sensing units of the thermistor type. All mixer unit and duct temperature sensors are interchangeable.



SYSTEM DESCRIPTION - ZONE CONTROLLER ... MIXER UNIT/DUCT TEMPERATURE SENSORS

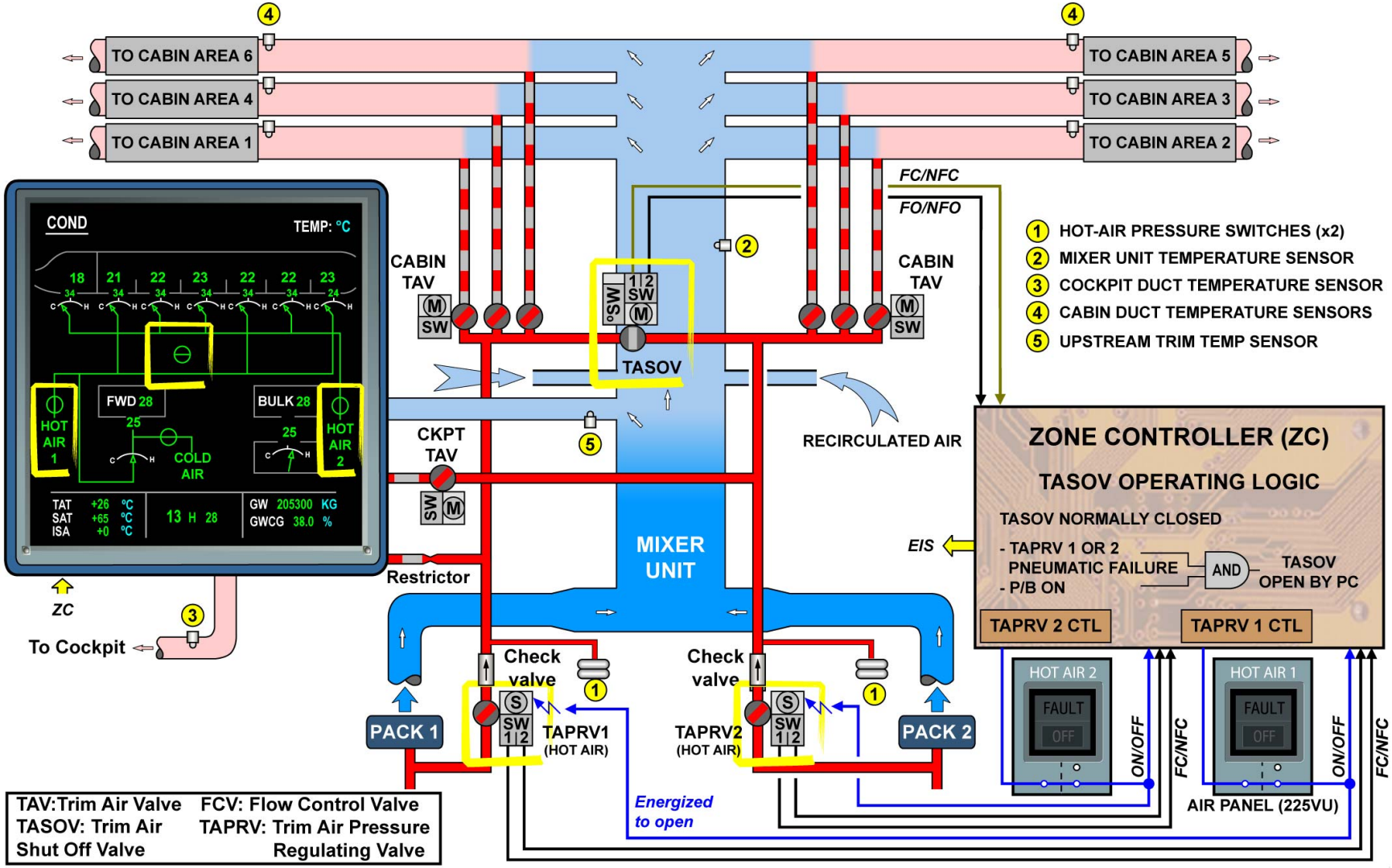
G94093341 - GAUT0T0 - FM21D5AIRCCTL03

COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

HOT AIR SUPPLY NORMAL OPERATION

The TAPRVs 1 and 2 supply pressure-regulated hot air to the TAVs for fine temperature adjustment. The two trim air systems can be interconnected through the TASOV installed on the hot air manifold. Each TAPRV has a hot air pressure regulation function and a hot air supply shut-off function.
The ZC opens TAPRVs 1 and 2 (solenoid energized), if:
- hot air is available, TAPRVs close when solenoids de-energized,
- HOT AIR P/BSW is set to ON, and the solenoid is energized; if pneumatic pressure is available, TAPRV opens and starts regulating the trim air pressure.

When open, TAPRVs 1 and 2 regulate the hot air pressure around 4 psi above the cabin pressure in order to make sure that proper hot air mixes up with conditioned air from the mixer unit in the different supply ducts.
The ZC sends the TAPRVs 1 and 2 and TASOV position signals to the EIS. These parameters are displayed on the ECAM COND page.



HOT AIR SUPPLY NORMAL OPERATION

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COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

COCKPIT/CABIN TEMPERATURE REGULATION - TARGET TEMPERATUR CALCULATION TEMPERATURE MONITORING

The ZC:
- calculates a target temperature for the cockpit and the cabin areas according to temperature selections on the AIR panel and Flight Attendant Panel (FAP),
- determines a pack temperature demand, which agrees with the lowest temperature demand from either the cockpit or the cabin areas,
- sends this signal to both Pack Controllers (PCs) for basic air temperature regulation,
- controls the trim air valves of areas for which the temperature demand is above the lowest value for fine temperature adjustment.

TARGET TEMPERATURE CALCULATION

The crew, via two temperature selectors located on the AIR panel, selects the basic reference temperatures. One selector is dedicated to the cockpit temperature regulation and the other one to the cabin. The selection range is between 18°C (COLD) and 30°C (HOT).
An additional altitude correction is added to all cockpit and cabin areas to compensate reduced humidity and decreased inside wall surface temperature. The altitude correction depends on:
- the A/C altitude from the Cabin Pressure Controllers (CPCs),
- a correction factor selected on the Environmental Control System (ECS) ALTITUDE CORRECTION page from the MCDU (ECS SPECIFIC DATA menu).

The altitude correction can reach either 1.5°C or 0.75°C at an altitude of 40,000 ft at the most, or be disabled using the MCDU specific data menu.
For each of the cabin areas, the reference temperature set by the cabin temperature selector can be increased or decreased by the cabin crew by using the CABIN TEMPERATURE page on the FAP. The offsets are limited to ± 3.0°C by increment of 0.5°C. The cabin offsets are sent to the ZC from the Cabin Intercommunication Data System (CIDS).

DUCT TEMPERATURE DEMAND CALCULATION

Each target temperature is compared to the actual temperature measured by the applicable cockpit or cabin temperature sensor. The ZC generates, for the cockpit and the cabin areas, a temperature error signal, which agrees with to a duct temperature demand.
The duct temperature demands are:
- limited to low and high values for the pack temperature demand calculation and the trim air valves control,
- unlimited for the calculation of demands sent to other A/C systems.

The limit values can be changed on the ECS DUCT TEMP LIMITATION page from the MCDU (ECS SPECIFIC DATA menu).

PACK TEMPERATURE DEMAND CALCULATION

The lowest of the duct temperature demands is compared to the actual temperature measured by the mixer unit temperature sensor (2). The ZC generates a mixer unit temperature error signal, which agrees with the pack temperature demand. This value is sent to both PCs and used as a reference temperature for pack 1 and pack 2-temperature control.

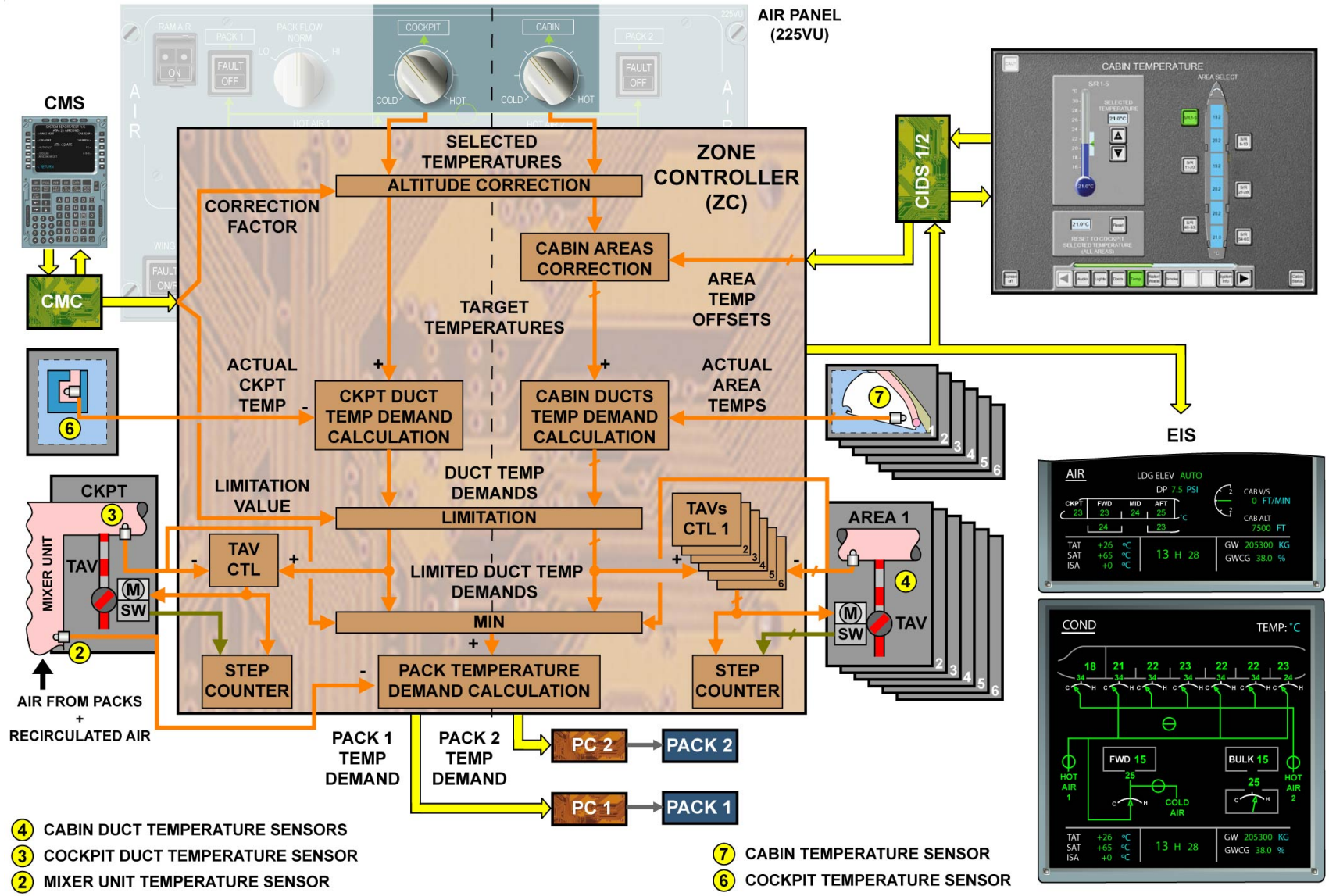
TRIM AIR VALVE CONTROL

The fine temperature adjustment in the cockpit and in each of the cabin areas is achieved by adding hot air through the trim air valves to the air from the packs and the recirculation system. Each trim air valve control is based on a duct temperature error calculation. For that function, the actual duct temperature, measured by the applicable duct temperature sensor (3 and 4), is compared to the related limited duct temperature demand. The trim air valve position is kept constant when the actual duct temperature is equal to the demand. Each trim air valve position monitoring is based on a step-counting principle.

TEMPERATURE MONITORING

The ZC sends the actual duct temperature signals to the EIS. These parameters are displayed on the ECAM COND page. The ZC also sends the actual cockpit and cabin area temperature signals to the EIS and CIDS. These parameters are displayed on the:

- ECAM COND page,
- ECAM CRUISE page,
- FAP CABIN TEMPERATURE page (cabin area temperatures only).



COCKPIT/CABIN TEMPERATURE REGULATION - TARGET TEMPERATUR CALCULATION TEMPERATURE MONITORING - TARGET TEMPERATURE CALCULATION ... TEMPERATURE MONITORING

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COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

COCKPIT/CABIN TEMPERATURE SENSORS

COCKPIT TEMPERATURE SENSORS

There is a temperature sensor in the cockpit located near the oxygen mask of the 3rd occupant. It gives zone temperature feedback to the ZC for zone temperature control, monitoring and indicating. The sensor is double element-sensing units of the thermistor type. The cockpit sensor are interchangeable.

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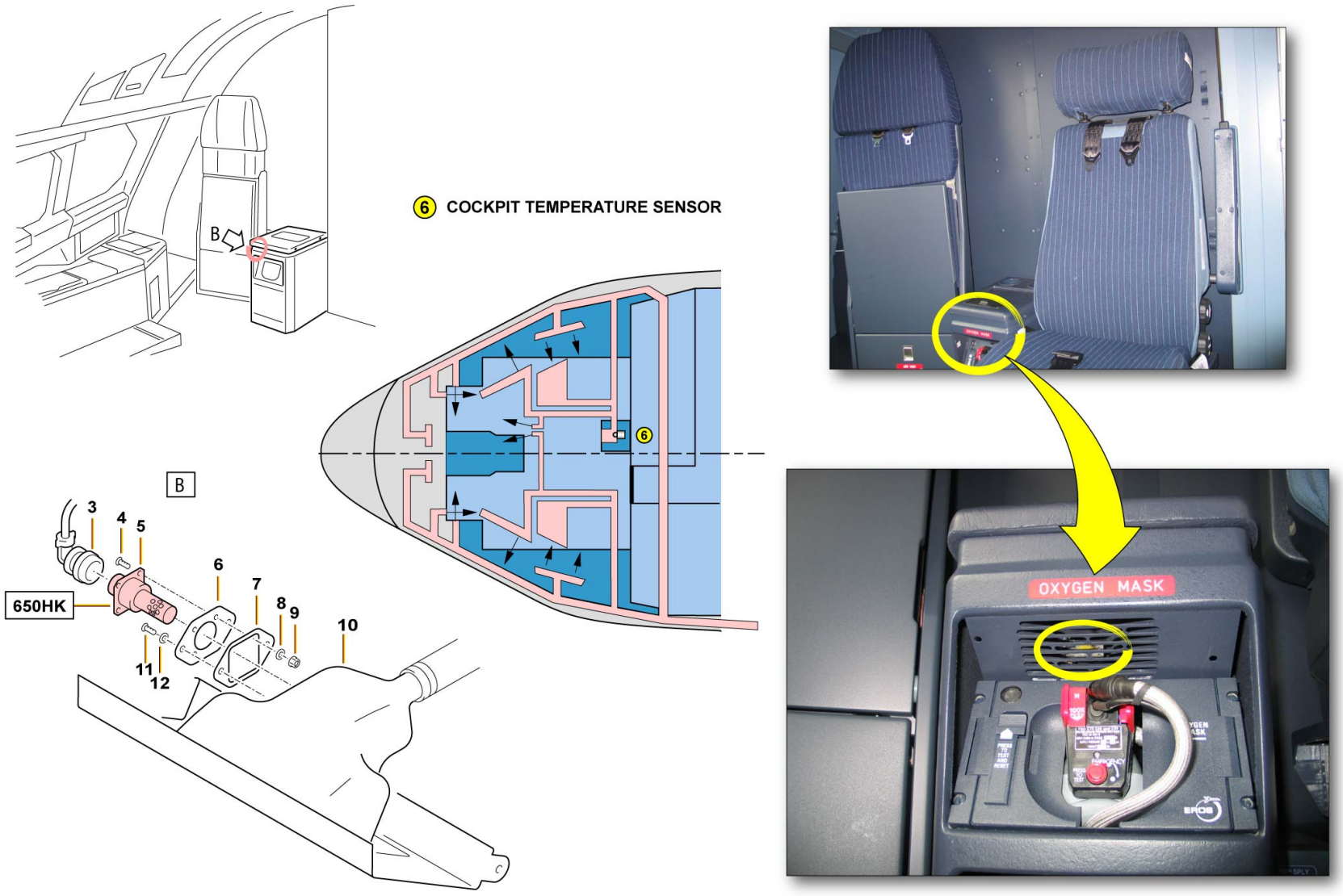


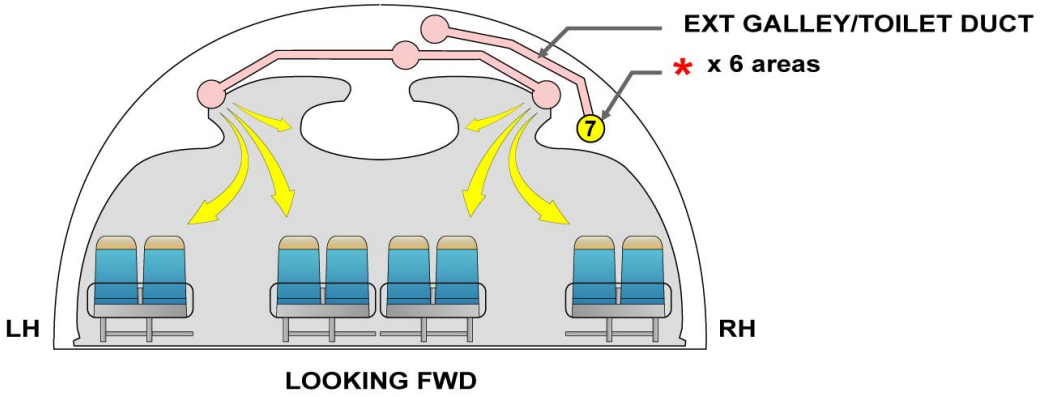
COCKPIT/CABIN TEMPERATURE SENSORS - COCKPIT TEMPERATURE SENSORS

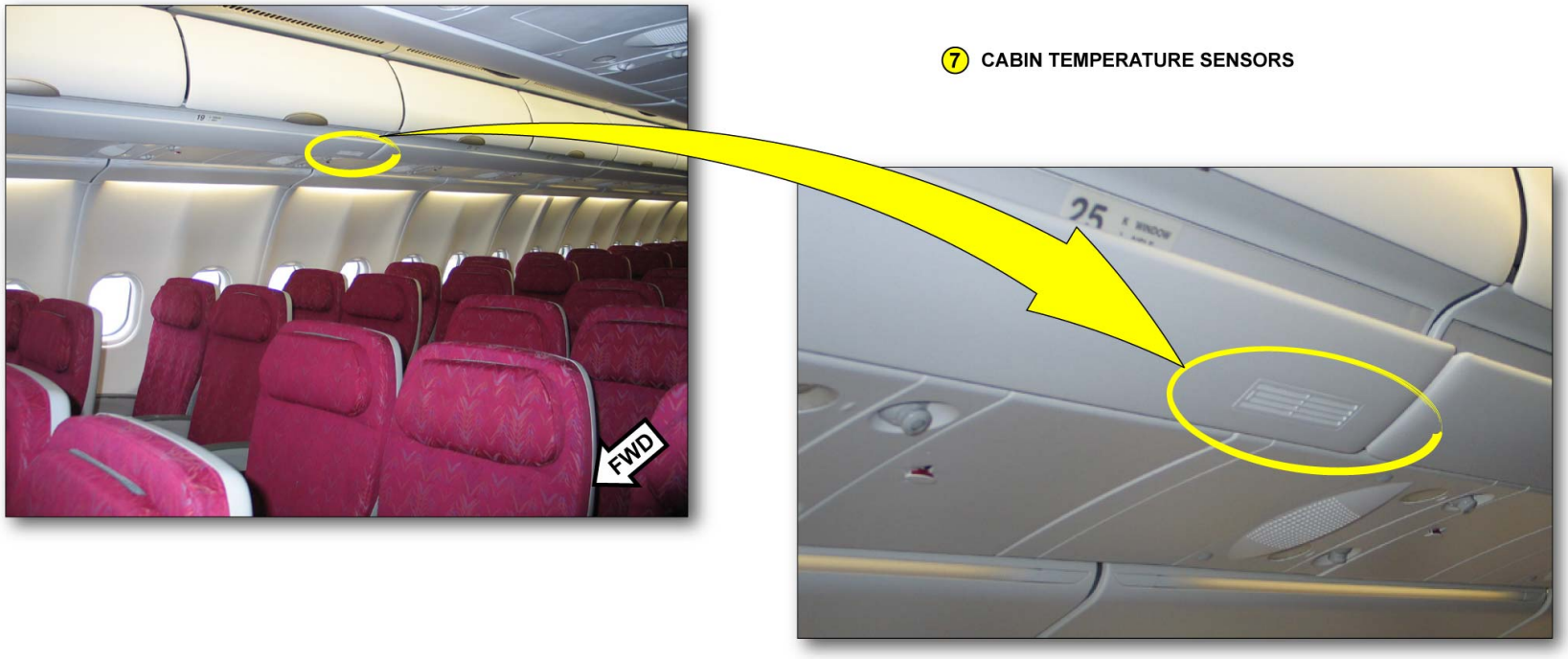
COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

COCKPIT/CABIN TEMPERATURE SENSORS (continued)

CABIN TEMPERATURE SENSORS

There is one temperature sensor per each of the 6 cabin areas located on the External Galley/Toilet duct. They give zone temperature feedback to the ZC for zone temperature control, monitoring and indicating. All sensors are double element-sensing units of the thermistor type. All cabin temperature sensors are interchangeable.





COCKPIT/CABIN TEMPERATURE SENSORS - CABIN TEMPERATURE SENSORS

COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

ZONE CONTROLLER INTERFACES (COMMANDS)

In case of insufficient cooling or heating capacity or non-satisfied temperature demands, the ZC generates additional demand signals to carry out the environmental temperature and flow requirements. These signals are sent to:
- a flow demand sent to the APU Electronic Control Box (ECB),
- a pressure demand sent to the Engine Interface and Vibration Monitoring Units (EIVMUs),
- a temperature demand sent to the BMCs,
- a crossbleed valve opening request sent to the BMCs.

The various demands are set to default values in case of ZC failure.

APU FLOW DEMAND

During ECS operation with APU bleed air supply, the thermal requirements of the zones will control the airflow taken from the APU. The ZC calculates an APU flow demand signal for the ECB according to:
- the lowest unlimited duct temperature demand when more cooling is required on a very hot day and the cooling capacity is not sufficient,
- the highest unlimited duct temperature demand when a maximum heating is required on a cold day and the packs together with the trim air valves are insufficient to satisfy the zone duct temperature demands.

EIVMU PRESSURE DEMAND

When the engines are at idle speed, the bleed air pressure can become too low to satisfy the zone cooling requirements. The ZC calculates a pressure demand signal for the EIVMUs, which has an effect on the idle speed of the engines. The EIVMU pressure demand signal varies according to the lowest unlimited duct temperature demand.

BLEED TEMPERATURE DEMAND

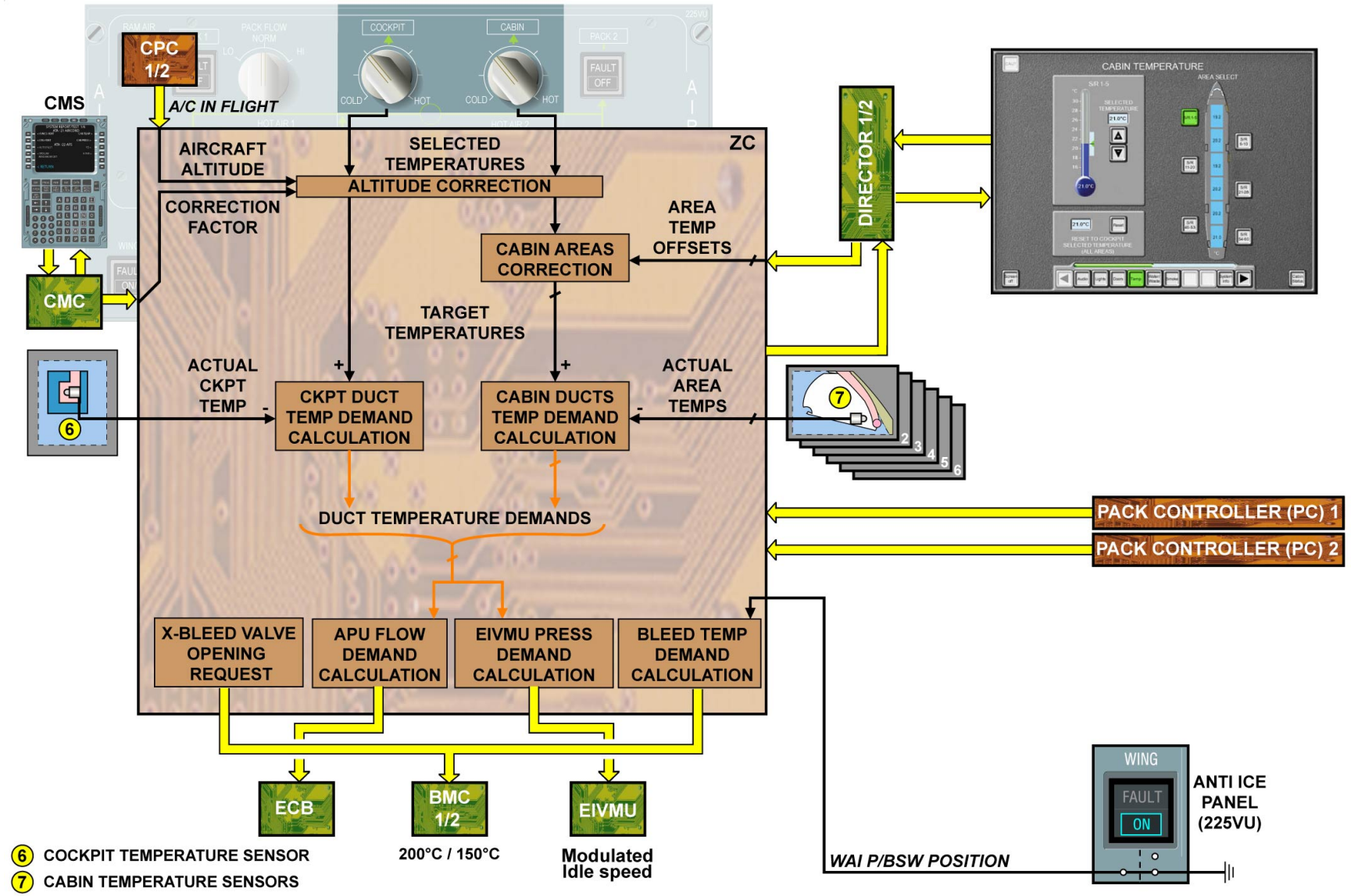
If the cooling capacity of the packs is not sufficient to maintain the selected temperature requirements for the cabin or cargo, a signal is sent to the BMCs by the ZC in order to decrease the bleed air temperature regulation from 200°C to 150°C. This bleed temperature demand is sent to the BMCs if:
- at least one pack is in full cooling mode (ram air outlet nearly FO) and the A/C is in flight,
- at least one pack temperature cannot meet its pack temperature demand.

The bleed temperature demand is inhibited during flight if the wing anti ice system is operative (WING ANTI ICE P/BSW set to ON).

CROSSBLEED VALVE OPENING REQUEST

During a single pack operation, it is necessary to open the crossbleed valve in order to:
- reduce the pressure drop inside the bleed system,
- increase the running pack power due to second bleed system activation.

The crossbleed valve open request is sent by the ZC to the BMCs if only one pack is operative and the APU bleed valve is closed.



ZONE CONTROLLER INTERFACES (COMMANDS) - APU FLOW DEMAND ... CROSSBLEED VALVE OPENING REQUEST

G9409341 - GAUT0T0 - FM21D5AIRCCTL03

COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

ABNORMAL OPERATION: DUCT OVERHEAT AND OVER PRESSURE

The system is able to:
- cope with a single trim air supply failure,
- cope with complete trim air supply loss,
- detect a duct overheat,
- detect an overpressure,
- cope with a ZC failure.

DUCT OVERHEAT DETECTION

A duct overheat condition is activated as soon as a duct temperature is sensed by the cockpit duct temperature sensor (3) or any one of the cabin duct temperature sensors (4) rises above 88°C.
Depending on the affected trim air system, the ZC will automatically close:
- the TAPRV,
- the applicable TAVs,
- the TASOV if open.

Moreover, if a duct overheat occurs in both trim air systems, the fine temperature in each zone will be completely lost.
The ZC will trigger:
- a FAULT light on the related HOT AIR P/BSW,
- an ECAM warning message on the EWD,
- an amber duct temperature indication on the ECAM COND page.

The duct overheat condition is reset if:
- the duct temperature drops below 70°C,
- the related HOT AIR P/BSW is set to OFF then back to ON.

As a consequence, the ZC reopens the applicable TAPRV and the FAULT light on the related HOT AIR P/BSW goes off.

OVERPRESSURE DETECTION

The hot air pressure switch (1) closes if the pressure rises above 6.5 psi in the applicable trim air supply system. Thus, an overpressure signal is sent to the ZC until the pressure drops back below 5 psi. Consequently, the ZC transmits.

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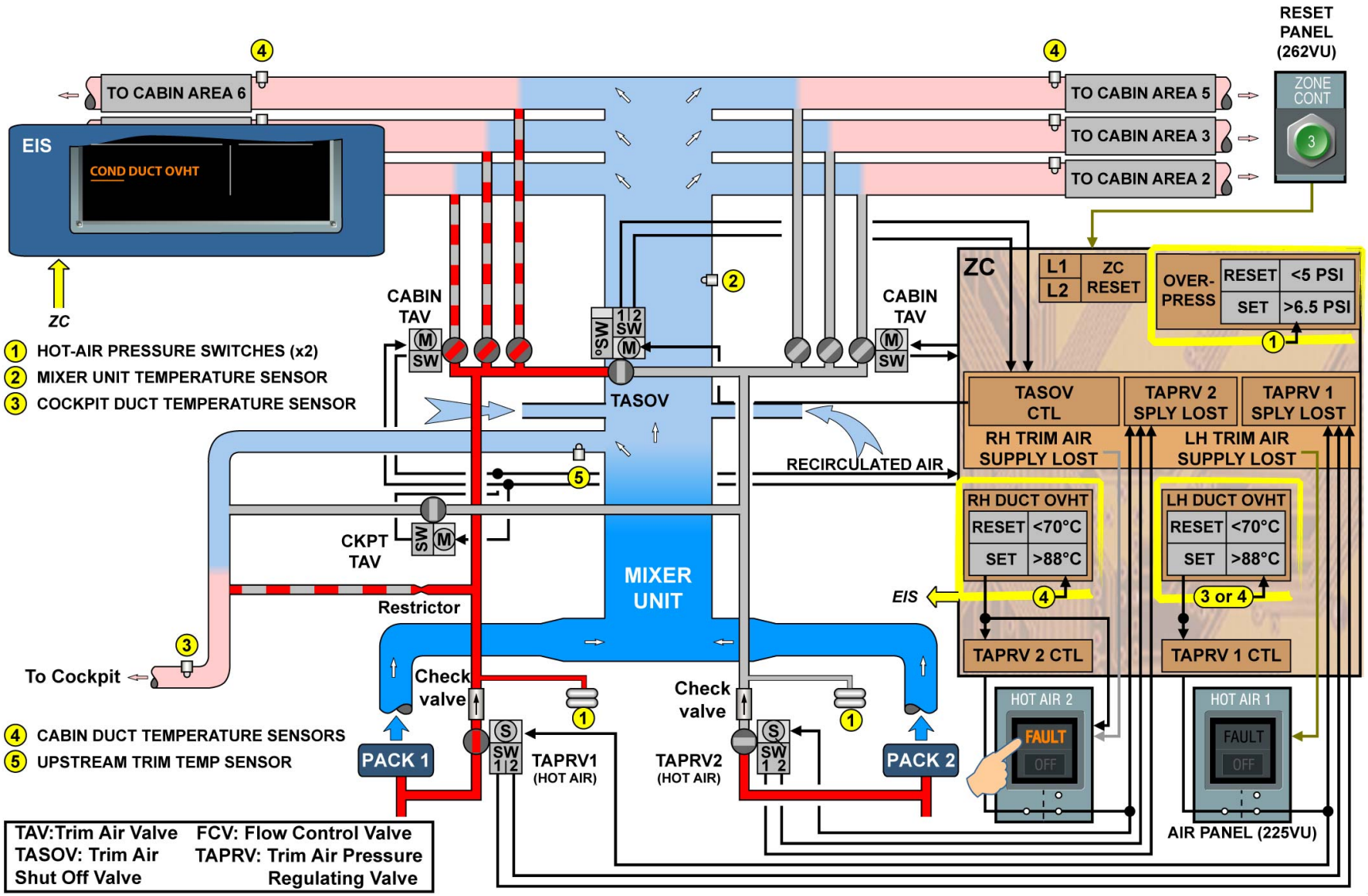

ABNORMAL OPERATION: DUCT OVERHEAT AND OVER PRESSURE - DUCT OVERHEAT DETECTION & OVERPRESSURE DETECTION

G9409341 - GAUT0T0 - FM21D5AIRCCTL03

COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

ABNORMAL OPERATION: HOT AIR SOURCE FAILURE

SINGLE TRIM AIR SUPPLY FAILURE

The ZC automatically opens the TASOV if one trim air supply is lost due to a TAPRV failed closed or spring-loaded closed (one pack off). It enables the system to restore hot air supply and thus fine temperature adjustment in the failed side. However, the TASOV is kept closed in case of manual TAPRV closure from the HOT AIR P/BSW.
A single trim air supply loss may occur if one TAPRV or the TASOV has failed closed. In such a case, the ZC automatically closes the affected TAVs. The ZC will also trigger:
- a FAULT light on the related HOT AIR P/BSW,
- an ECAM warning message on the EWD,
- an amber TAPRV position indication on the ECAM COND page,
- an amber TASOV position indication on the ECAM COND page.

COMPLETE TRIM AIR SUPPLY LOSS

The fine temperature adjustment is no longer possible when both trim air supplies are lost. This may occur if both TAPRVs have failed closed. In such a case, the ZC automatically closes all TAVs. The ZC will also trigger:
- a FAULT light on both HOT AIR P/BSWs,
- an ECAM warning message on the EWD,
- an amber TAPRVs 1 and 2 position indication on the ECAM COND page.

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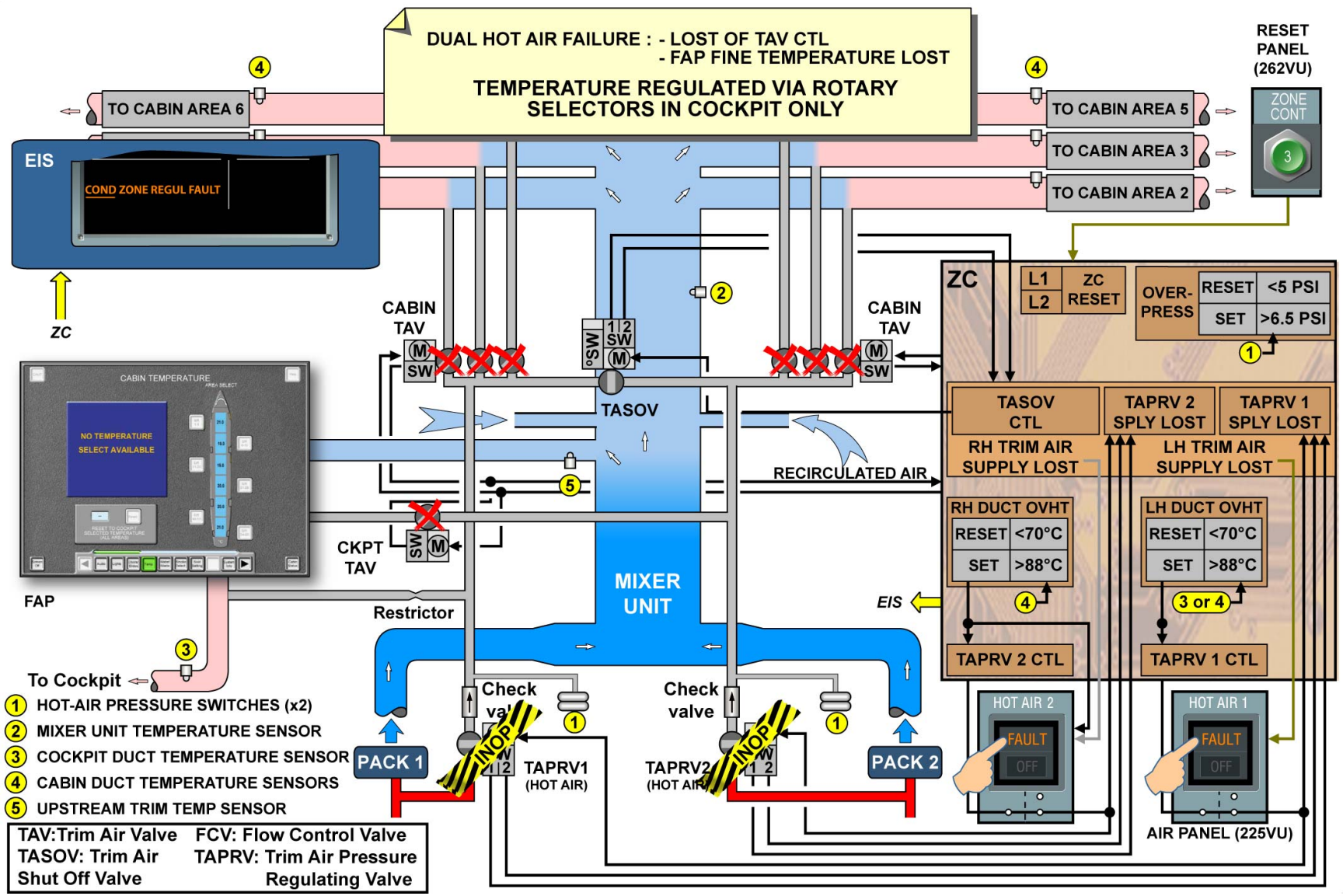


ABNORMAL OPERATION: HOT AIR SOURCE FAILURE - SINGLE TRIM AIR SUPPLY FAILURE & COMPLETE TRIM AIR SUPPLY LOSS

G9409341 - GAUT0T0 - FM21D5AIRCCTL03

COCKPIT/CABIN AIR TEMPERATURE CONTROL D/O (3)

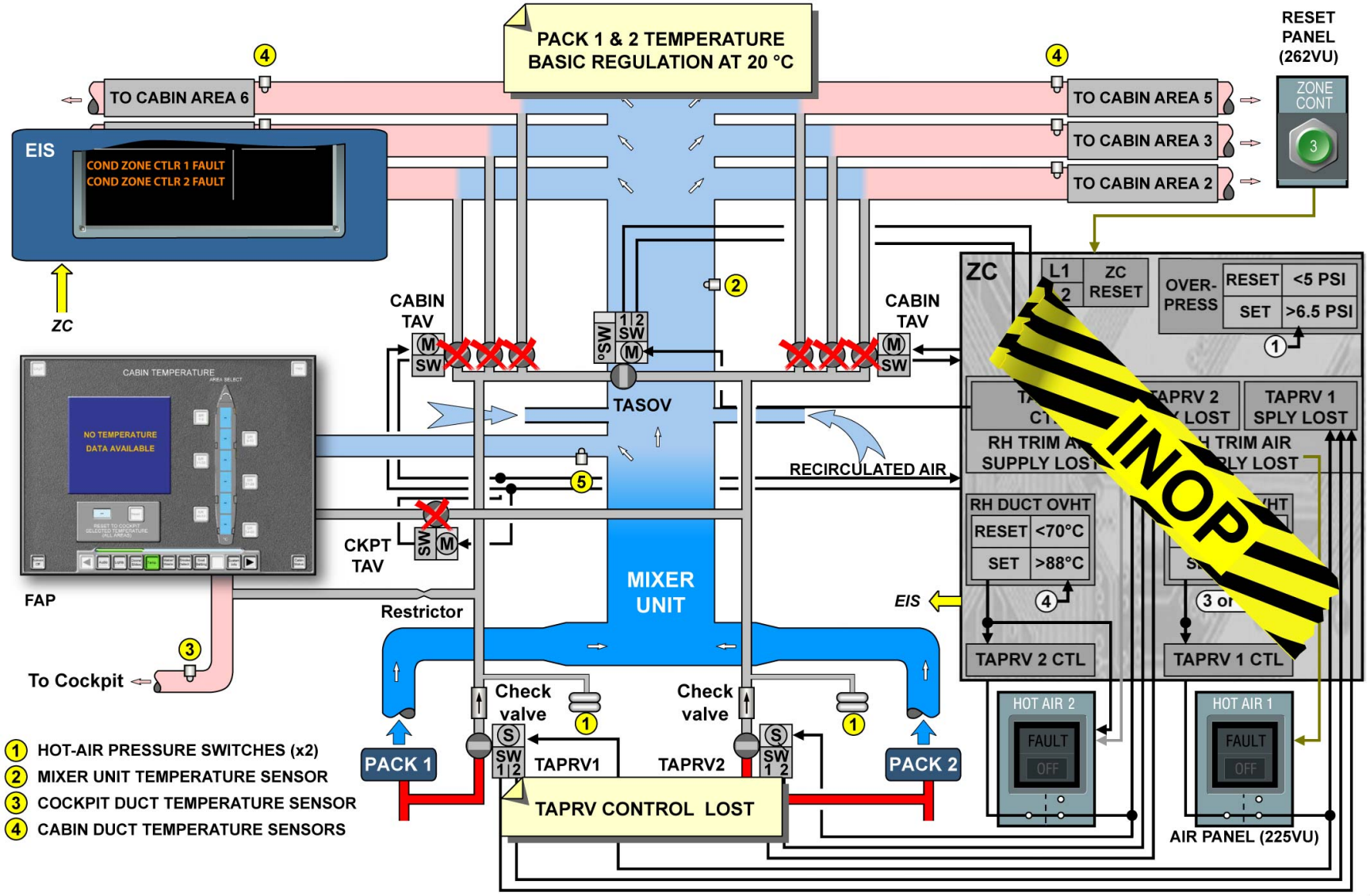
ABNORMAL OPERATION: ZONE CONTROLLER TOTAL FAILURE (LANE 1+2 FAIL)

All control and monitoring functions remain if one lane has failed. The other lane takes over and triggers:
- an ECAM warning message on the EWD,
- an amber ZC lane indication on the ECAM COND page.

A full ZC failure or ZC power supply loss leads to the closure of the TAPRVs (solenoid de-energized). The TAVs and TASOV remain in their last position and the fine temperature adjustment is no longer possible. As no data is available, the PCs set the various demands usually sent by the ZC to default values. Indications about the cockpit and cabin temperature control system are no longer available on the:
- ECAM COND page,
- ECAM CRUISE page,
- FAP CABIN TEMPERATURE page.

Moreover, the EIS triggers:
- an ECAM warning message on the EWD,
- an amber ZONE CTLR indication on the ECAM COND page.

The ZC can be reset from the ZC reset P/B located on the RESET panel.



ABNORMAL OPERATION: ZONE CONTROLLER TOTAL FAILURE (LANE 1+2 FAIL)

G9409341 - GAUT0T0 - FM21D5AIRCCTL03

AIR RECIRCULATION AND MANAGEMENT D/O (3)

SYSTEM DESCRIPTION

The system makes:
- the recirculation flow regulation,
- the cabin air filtering,
- the avionics equipment air supply.

RECIRCULATION FANS

The two re-circulation fans are constant speed fans. Each fan has:
- a fan wheel in a housing,
- a three-phase 115V AC induction synchro motor,
- thermal switches.

The thermal switches shut off the power supply to protect the motor in case of temperature overheat.

RECIRCULATION VALVES

The two re-circulation valves are shut-off butterfly valves. Each valve is mechanically actuated by a 28V DC motor and electrically controlled from the Ventilation Controller (VC). The recirculation valves have two positions, open or closed. In closed position, the butterfly still allows airflow through the valve, so they operate as restrictors. Each valve has 2 limit switches for Fully Closed/Not Fully Closed (FC/NFC) and Fully Opened/Not Fully Opened (FO/NFO) position indication. There is a manual lever used to see the butterfly valve position and to manually change it.

RECIRCULATION FILTER-HOUSINGS/FILTERS

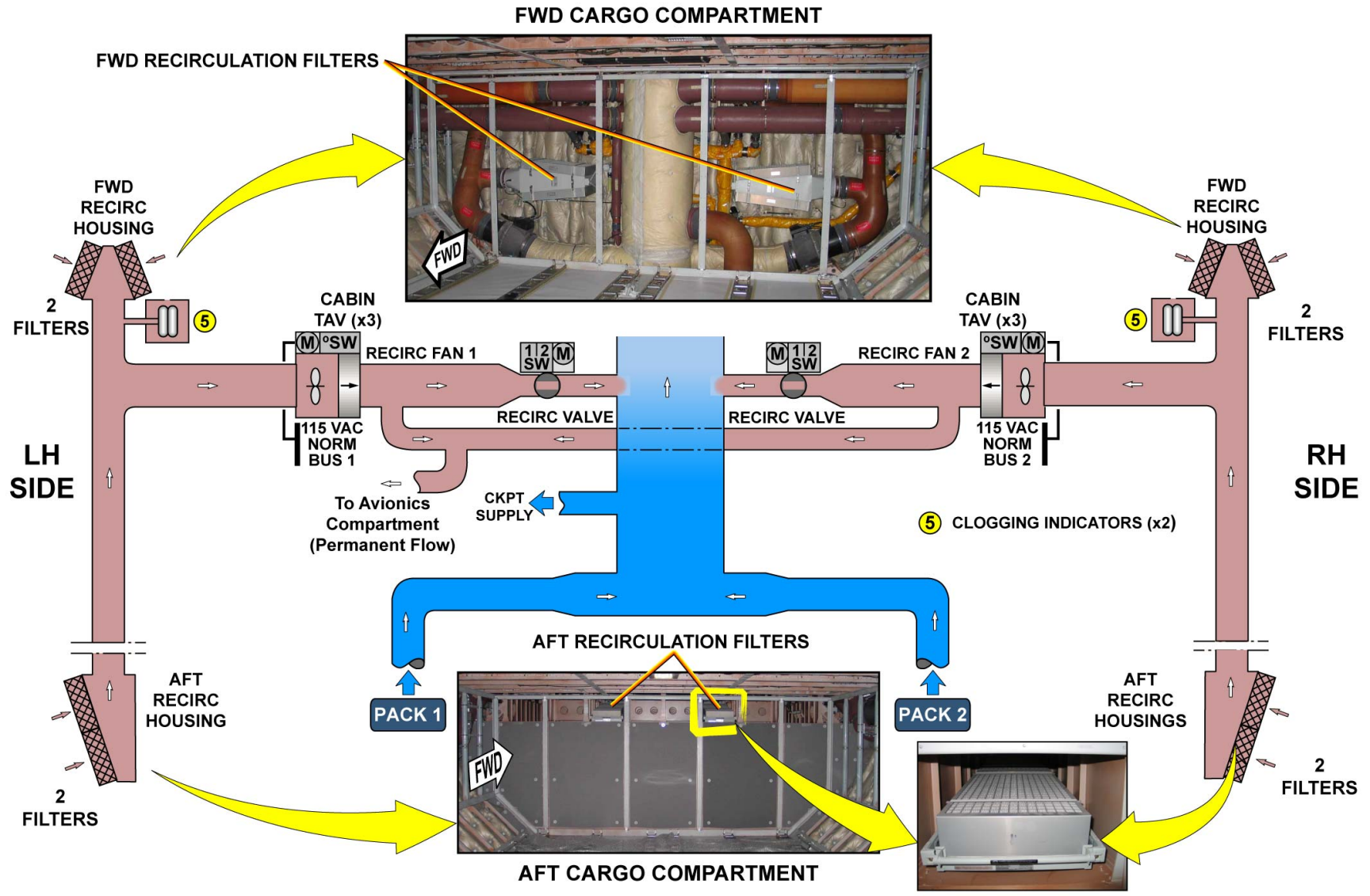
There are two FWD filter-housings located at the rear of the FWD cargo compartment, near the mixer unit. Each one has:
- a double frame,
- a pressure port for the clogging indicator connection,
- quick release fasteners for filter locking,
- 2 filter elements.

There are 2 aft filter-housings located at the front of the aft cargo compartment. Each one has:
- a single frame,
- quick release fasteners for filter locking,
- 2 filter elements.

All filter elements are identical and disposable.

CLOGGING INDICATORS

There are two clogging indicators. Each one is connected through a duct to a FWD recirculation filter-housing. The clogging indicators are differential pressure switches.



SYSTEM DESCRIPTION - RECIRCULATION FANS ... CLOGGING INDICATORS

G9409341 - GAUT0T0 - FM21D6AIRRECI03

AIR RECIRCULATION AND MANAGEMENT D/O (3)

RECIRCULATION FANS SHUT-OFF

The VC will automatically stop the fans through discrete OFF command signals according to:
- the CAB FANS P/BSW position,
- fan overheat status.

ON/OFF FUNCTION

The VC stops both recirculation fans when the CAB FAN P/BSW is set to OFF.

FAN OVERHEAT/RESET

In case of fan overheat, the VC gets a FAN OVERHEAT STATUS signal via the CAN bus and sends back a discrete OFF command signal to the concerned recirculation fan. The VC will also trigger:
- the FAULT light on the OVHT COND FANS RESET P/B,
- a related ECAM warning message on the EWD,
- an amber FAN symbol on the COND page.

If the overheat condition no longer exists and if the OVHT COND FANS RESET P/B is pressed in, a common FAN RESET signal is sent to the VC. The FAULT light on the OVHT COND FANS RESET P/B and related warnings will go off. The VC will send a discrete ON command signal to the concerned recirculation fan.

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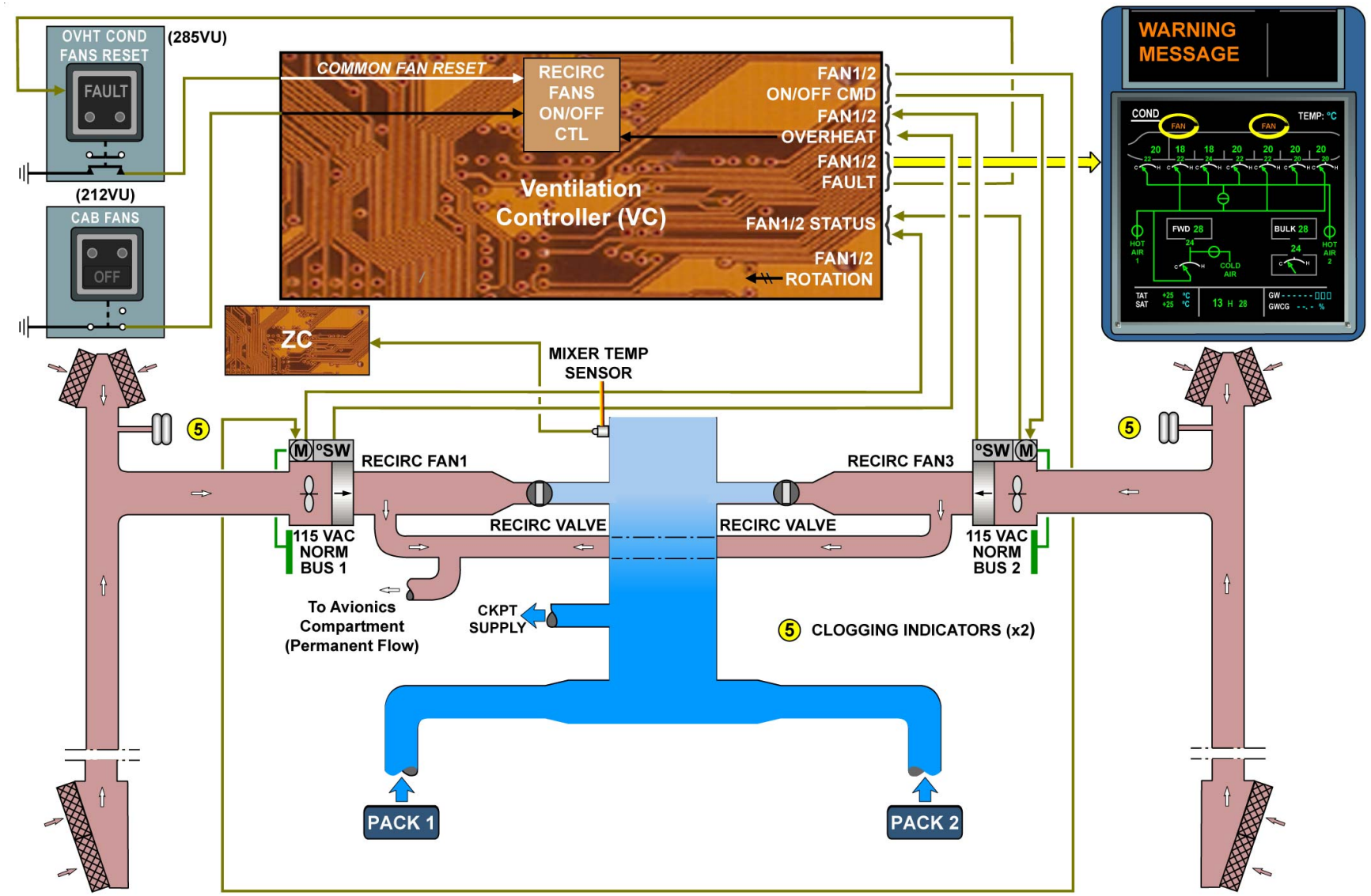


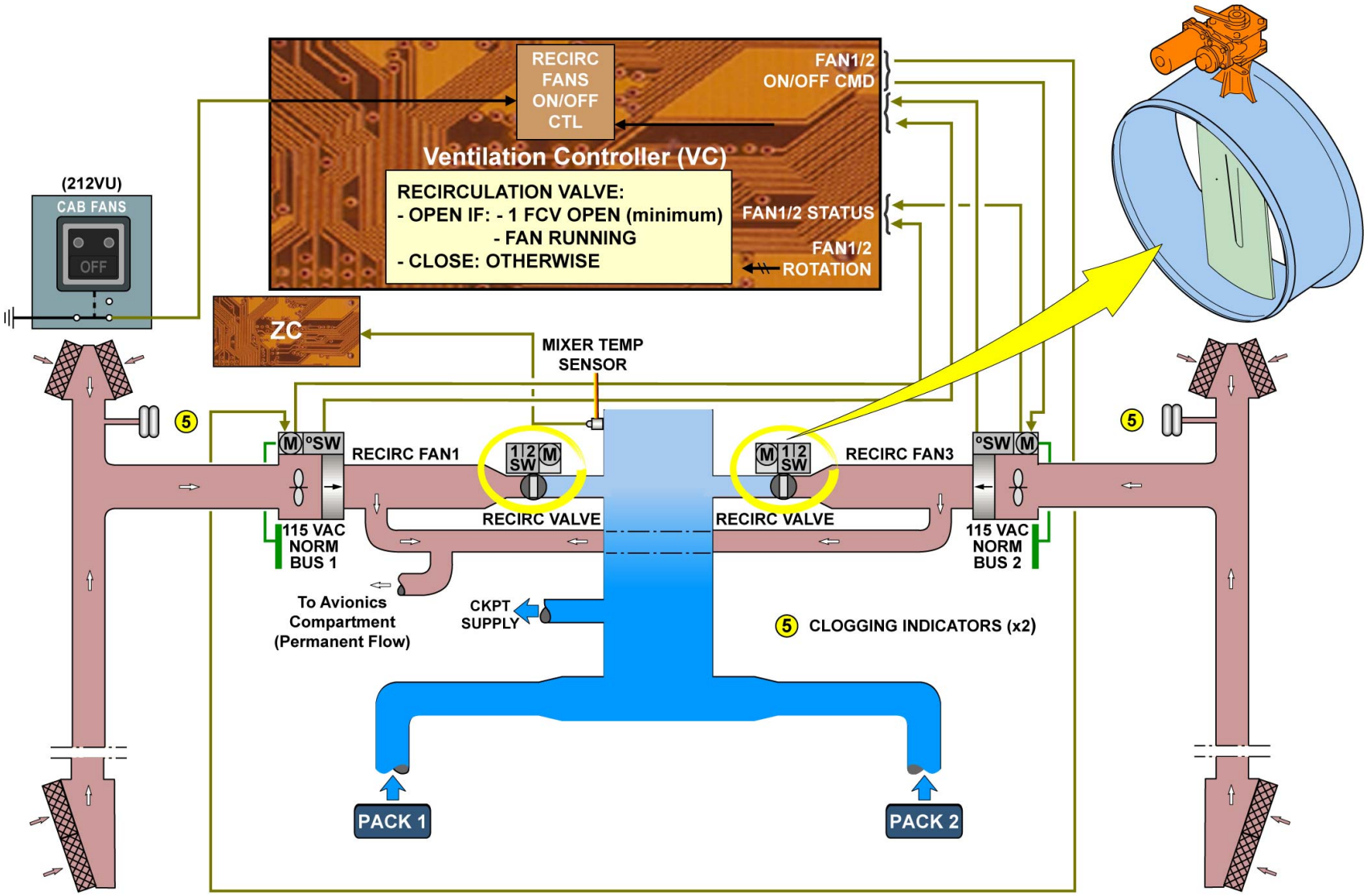
RECIRCULATION FANS SHUT-OFF - ON/OFF FUNCTION & FAN OVERHEAT/RESET

G9409341 - GAUT0T0 - FM21D6AIRRECI03

AIR RECIRCULATION AND MANAGEMENT D/O (3)

RECIRCULATION VALVES CLOSURE

The two recirculation valves are normally controlled to the open position.
In order to supply sufficient air to the avionics compartment, the VC controls both valves to close if:
- both packs are off (FCV1 and FCV2 FC),
- at least one fan out of fan 1 and fan 2 is operative.



RECIRCULATION VALVES CLOSURE

G9409341 - GAUT0T0 - FM21D6AIRRECI03

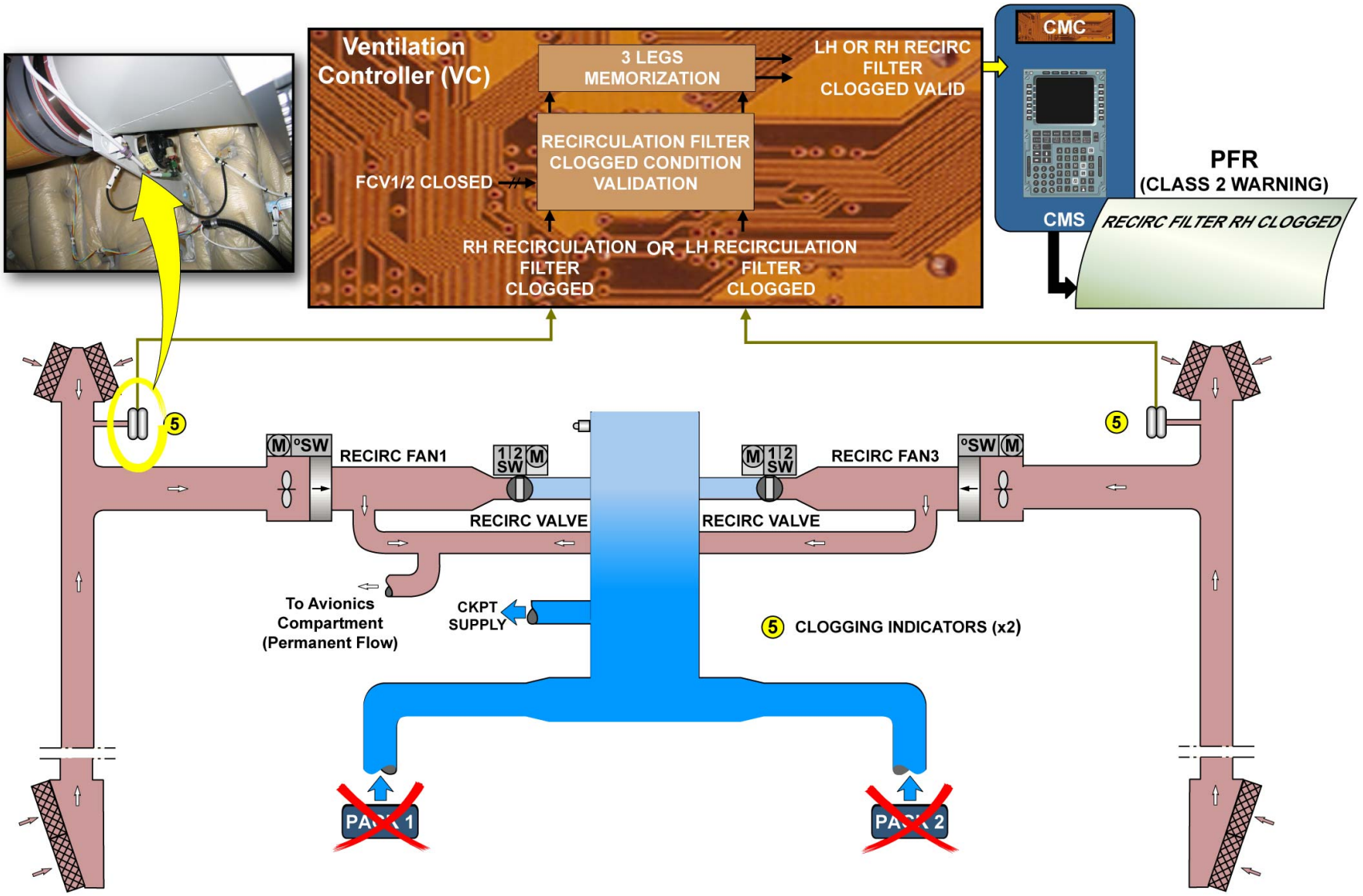
AIR RECIRCULATION AND MANAGEMENT D/O (3)

RECIRCULATION FILTERS CLOGGING

In case of filter clogging, the related clogging indicator detects a differential pressure and sends a signal to the VC. This signal is valid only if:
- the A/C is on ground,
- both packs are off (FCV1 and FCV 2 FC),
- both recirculation fans are operative.

The recirculation filter clogged valid signal is transmitted as a class 2 failure to the Central Maintenance Computer (CMC) if it has been detected in 3 different flight legs.

G9409341 - GAUT0T0 - FM21D6AIRRECI03



RECIRCULATION FILTERS CLOGGING

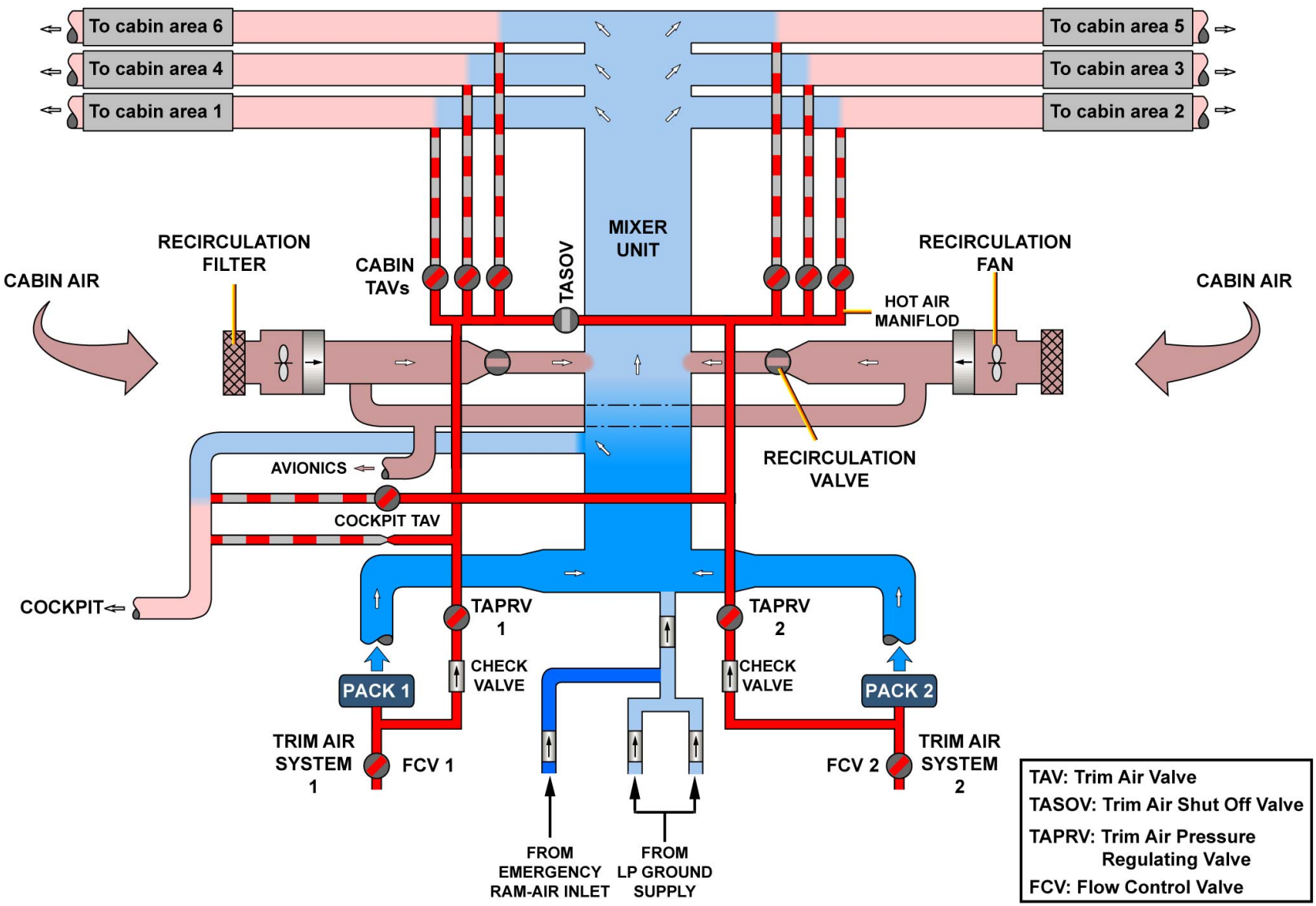
G9409341 - GAUT0T0 - FM21D6AIRRECI03

COCKPIT/CAB AIR DISTRIBUTION & VENT D/O (3)

AIR DISTRIBUTION

The air distribution system supplies controlled temperature and conditioned air to the cabin, cockpit, lavatory and galley areas. The cabin is divided into 6 areas. Each cabin area corresponds to a distribution duct coming from the mixer unit. In each zone, distribution is equally split between left and right hand sides. Used cabin air, which has entered the underfloor area, is drawn by recirculation fans to the mixer unit. The fresh air that enters the mixer unit in normal operation comes from the air conditioning packs. In flight, if both air conditioning packs are not serviceable, outside ambient can be used to supply the mixer unit through the emergency ram air inlet. When the aircraft is on ground, a ground air cart can be connected to the LP ground connectors. This can supply air to the distribution network without operation of the packs.

G9409341 - GAUT0T0 - FM21DG000000001



AIR DISTRIBUTION

G9409341 - GAUT0T0 - FM21DG000000001

COCKPIT/CAB AIR DISTRIBUTION & VENT D/O (3)

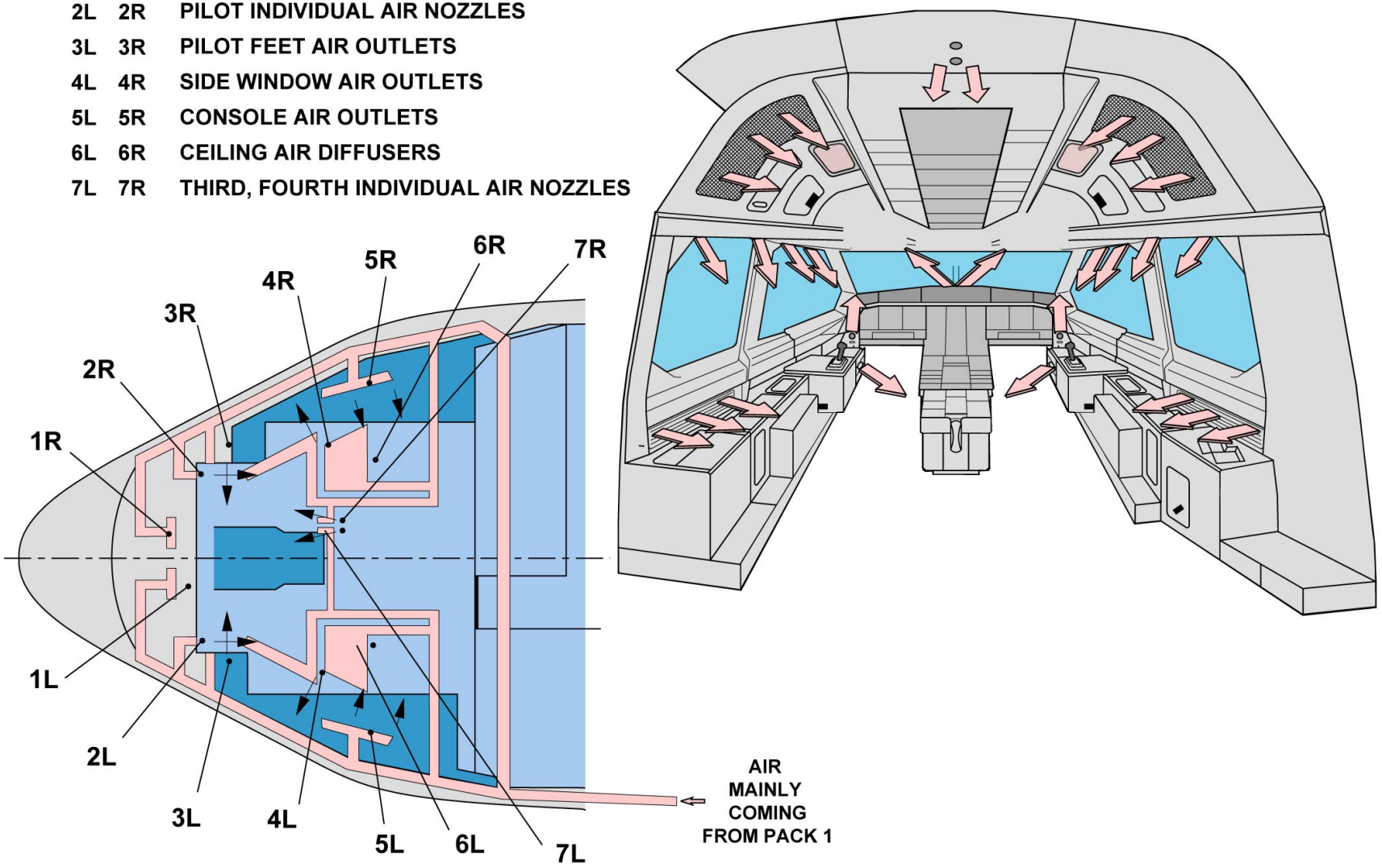
AIR DISTRIBUTION (continued)

COCKPIT AIR DISTRIBUTION

The cockpit supply duct is connected to a cockpit duct network in order to spread the air throughout the cockpit zone. Air enters the cockpit through fixed and adjustable outlets. It is extracted through vents in the floor. Cockpit air supply mainly comes from pack 1 even if air goes through the mixer unit. It minimizes the possibility of smoke and odors entering the cockpit from other compartments.

G9409341 - GAUT0T0 - FM21DG000000001

1L	1R	WINDSHIELD AIR OUTLETS
2L	2R	PILOT INDIVIDUAL AIR NOZZLES
3L	3R	PILOT FEET AIR OUTLETS
4L	4R	SIDE WINDOW AIR OUTLETS
5L	5R	CONSOLE AIR OUTLETS
6L	6R	CEILING AIR DIFFUSERS
7L	7R	THIRD, FOURTH INDIVIDUAL AIR NOZZLES



AIR DISTRIBUTION - COCKPIT AIR DISTRIBUTION

G9409341 - GAUT0T0 - FM21DG000000001

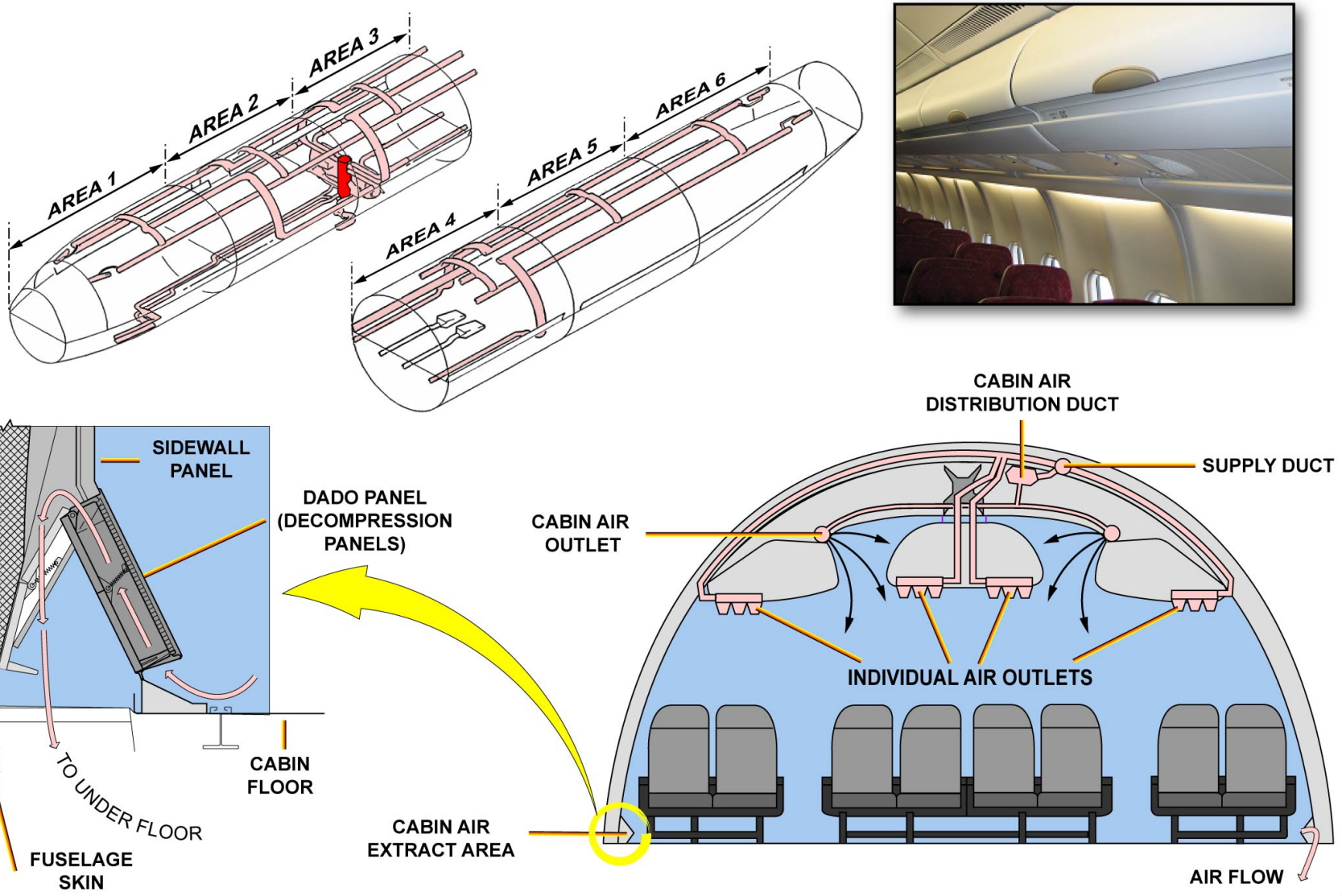
COCKPIT/CAB AIR DISTRIBUTION & VENT D/O (3)

AIR DISTRIBUTION (continued)

CABIN AIR DISTRIBUTION

The system supplies controlled temperature and conditioned air to each cabin passenger area and to each passenger through individual air outlets from the cabin distribution ducts. The distribution ducts are installed in the ceiling area of the cabin. The air then flows to supply ducts at overhead storage compartment level and in the lateral and center overhead stowages and out of the individual air outlets. The individual air outlets are installed in the Passenger Service Information Unit (PSIU). Flexible hoses connect the supply ducts to individual air outlets. Each individual air outlet has a ball mechanism, which permits the airflow to be adjusted. The same type of air outlet is also installed in the lavatories. Ambient air is extracted through vents at the floor level. It is then either recirculated or discharged overboard by the pressurization system.

G9409341 - GAUT0T0 - FM21DG000000001



AIR DISTRIBUTION - CABIN AIR DISTRIBUTION

G9409341 - GAUT0T0 - FM21DG000000001

GALLEY AND TOILET VENTILATION D/O (3)

SYSTEM DESCRIPTION

The system performs the:
- galley and toilet ventilation control and monitoring,
- abnormal/degraded operation handling.

VENTILATION CONTROLLER (VC)

The Ventilation Controller (VC) contains two independent computer lanes, each of which is able to perform all control, monitoring and BITE functions. One of these lanes is designated as being "active" while the other lane remains in a passive "hot-standby" mode. An automatic changeover occurs at the end of each flight or during the flight, if there is a failure in the active lane. Should a fault exist in both lanes, active control will be passed to the lane with the least significant fault. A covered RS 232 test equipment connector is fitted to the controller. The VC provisions are defined through pin programming.

EXTRACTION FAN

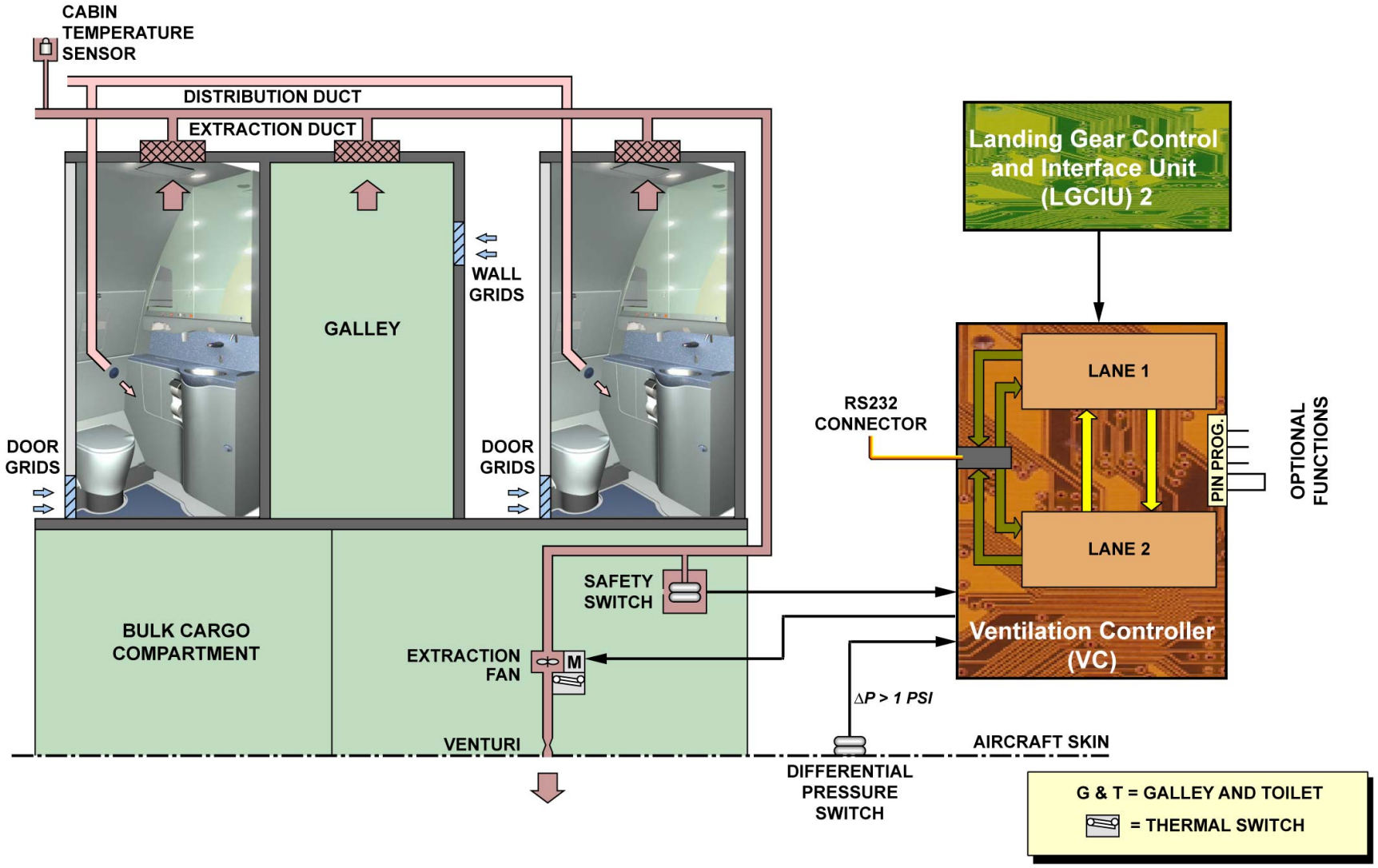
The extraction fan is a single speed fan. It is driven by a three-phase induction motor and controlled from the VC. Thermal switches ensure overheat protection by cutting off the motor power supply.

SAFETY SWITCH

The safety switch is a differential pressure switch. It detects any negative differential pressure between the cabin and the extraction duct and sends a signal to the VC.

DIFFERENTIAL PRESSURE SWITCH

The differential pressure switch measures the difference between the internal and external pressure and sends a signal to the VC if the pressure is above 1 psi. It is used to stop the extraction fan. This differential pressure switch is fitted in the FWD cargo compartment, near to the cargo door.



SYSTEM DESCRIPTION - VENTILATION CONTROLLER (VC) ... DIFFERENTIAL PRESSURE SWITCH

G9409341 - GAUT0T0 - FM21D7VENTLAV03

GALLEY AND TOILET VENTILATION D/O (3)

NORMAL OPERATION

The ventilation system is automatically controlled by the VC, using Flight/Ground input from LGCIU 2. In normal conditions, the VC controls the extraction fan. The galley and toilet ventilation is ensured by differential pressure, when the differential pressure is greater than 1 psi. The VC switches on the extraction fan power supply when aircraft is on ground, or in flight if the differential pressure is less than 1 psi. The VC monitors the extraction fan power feedback.

ABNORMAL/DEGRADED OPERATION

GENERAL

The galley and toilet extraction fan stops in case of:
- ditching,
- both packs off,
- emergency configuration,
- fan failure,
- fan overheat,
- VC failure.

The system is also able to detect an underpressure condition in the extraction duct. In case of VC fault or fan fault status on ground, the cabin temperature sensors are no longer properly ventilated and cabin temperature measurement is not accurate enough to be used as actual temperature. The Zone Controller (ZC) shall use a fixed duct temperature demand depending on the Total Air Temperature (TAT) for the cabin temperature regulation.

DITCHING

When ditching is selected on the DITCHING P/BSW, the VC stops the extraction fan.

BOTH PACKS OFF

When no air conditioning is available (both packs off), the VC stops the extraction fan.

EMERGENCY CONFIGURATION

If the aircraft is in an emergency configuration (loss of all four main AC-bus bars), the VC shuts down the extraction fan.

FAN FAILURE

If no power feedback is received, the VC switches off the extraction fan power supply and triggers an ECAM warning message on the EWD.

FAN OVERHEAT/RESET

In case of fan overheat condition, thermal switches cut off the extraction fan power supply. The VC triggers a FAULT light on the OVHT COND FANS RESET P/BSW and latches the fan overheat condition. The fan overheat condition can be reset by pushing the OVHT COND FANS RESET P/BSW. As a consequence, the FAULT light goes off and the extraction fan starts again, provided the overheat condition is no longer present.

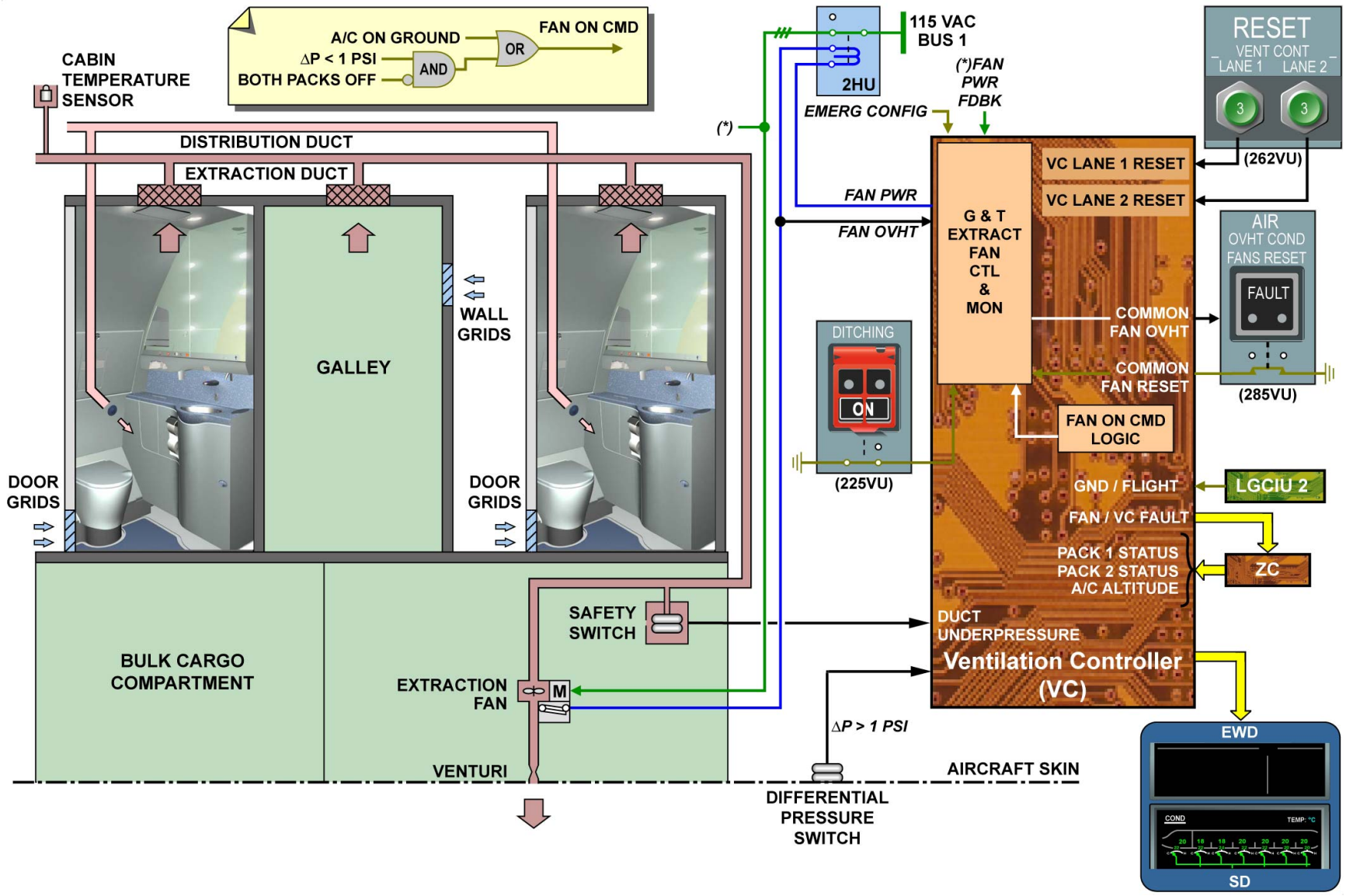
UNDERPRESSURE

The VC triggers an ECAM warning message on the EWD when an underpressure condition is sensed by the safety switch at an aircraft altitude greater than 20.000 ft during three consecutive flight legs.

VENTILATION CONTROLLER FAILURE

All control and monitoring functions remain if one lane has failed. The other lane takes over and triggers:
- an ECAM warning message on the EWD,
- an amber VC lane indication on the ECAM COND page.

The VC faulty lane can be reset from the dedicated VENT CONT LANE reset P/B located on the RESET panel.



NORMAL OPERATION & ABNORMAL/DEGRADED OPERATION

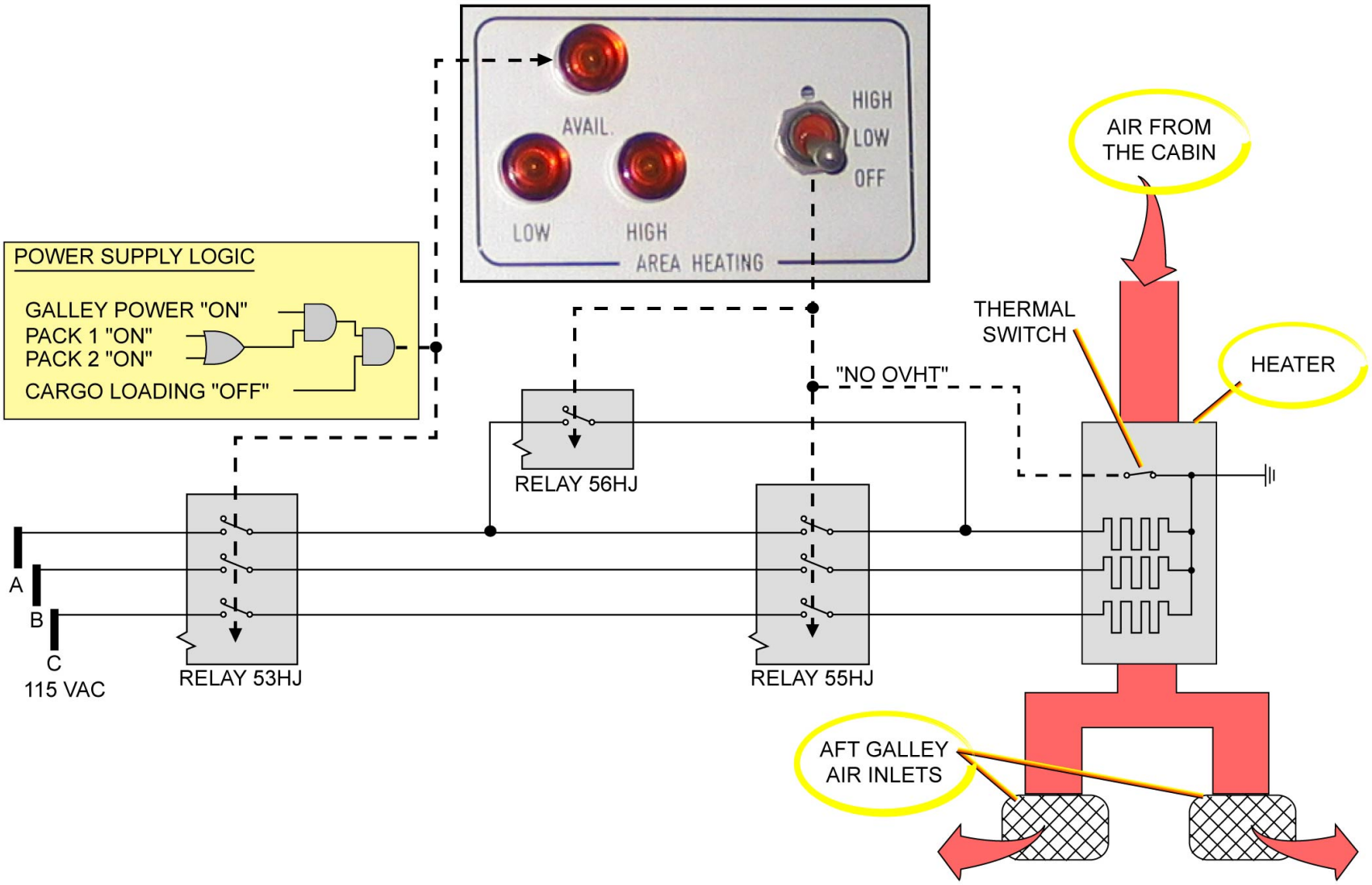
G9409341 - GAUT0T0 - FM21D7VENTLAV03

AFT GALLEY HEATING D/O (3)

GENERAL

The aft galley-area heating system increases the temperature of the air in the aft galley area. The air comes from the cabin air supply area and flows through a heater located in the upper part of the aft galley.

G9409341 - GAUT0T0 - FM21DJ000000001


AVAIL.
HIGH
LOW
OFF
LOW
HIGH
AREA HEATING
POWER SUPPLY LOGIC
GALLEY POWER "ON"
PACK 1 "ON"
PACK 2 "ON"
CARGO LOADING "OFF"
AIR FROM THE CABIN
THERMAL SWITCH
HEATER
"NO OVHT"
RELAY 56HJ
A
B
C
115 VAC
RELAY 53HJ
RELAY 55HJ
AFT GALLEY AIR INLETS

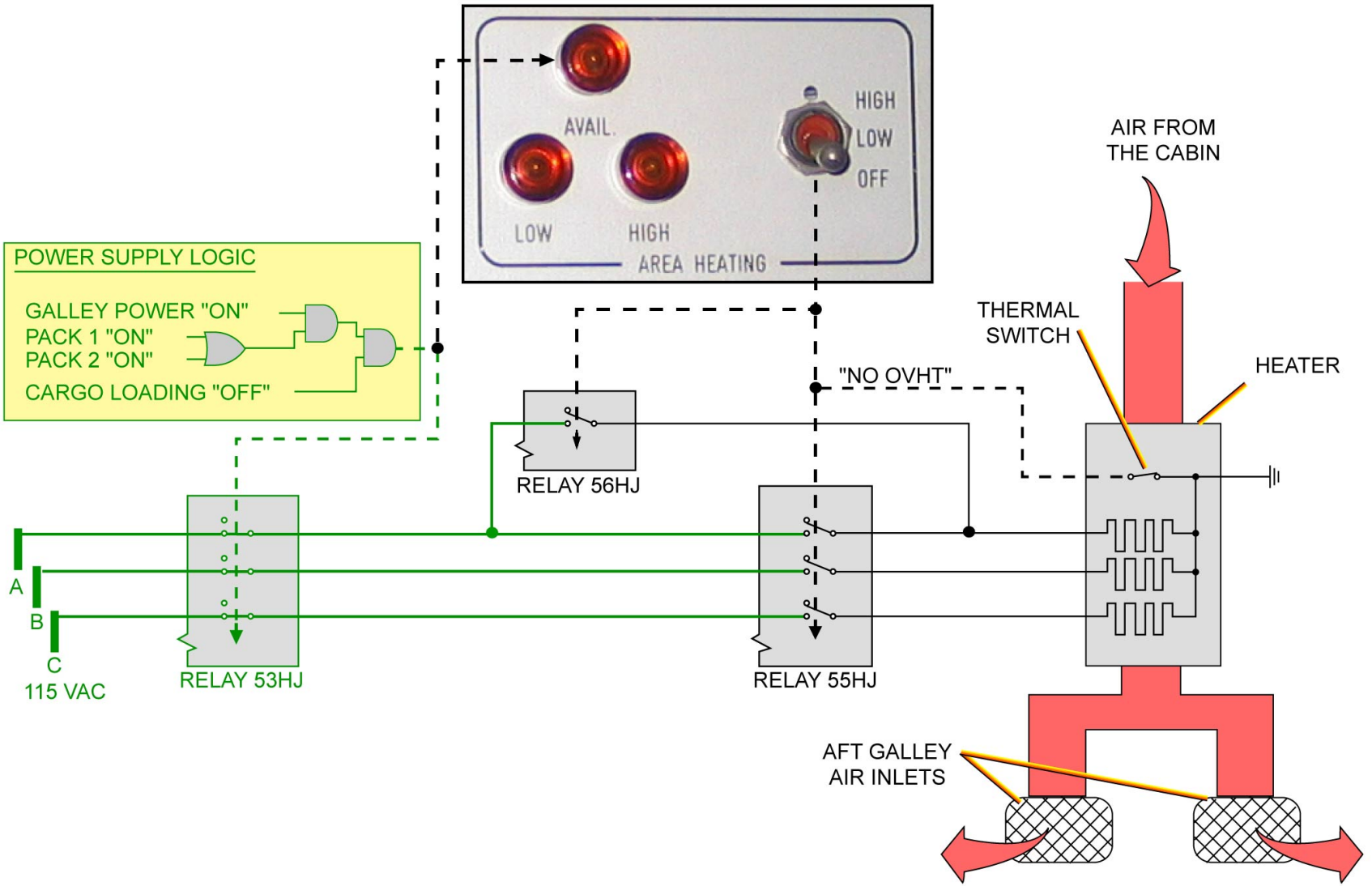
GENERAL

AFT GALLEY HEATING D/O (3)

POWER SUPPLY LOGIC

The heater is powered by the 115 VAC service bus. The 115 VAC is available only if at least one air conditioning pack operates and galley power is "ON" provided the cargo loading is not operating.

G9409341 - GAUT0T0 - FM21DJ000000001



POWER SUPPLY LOGIC

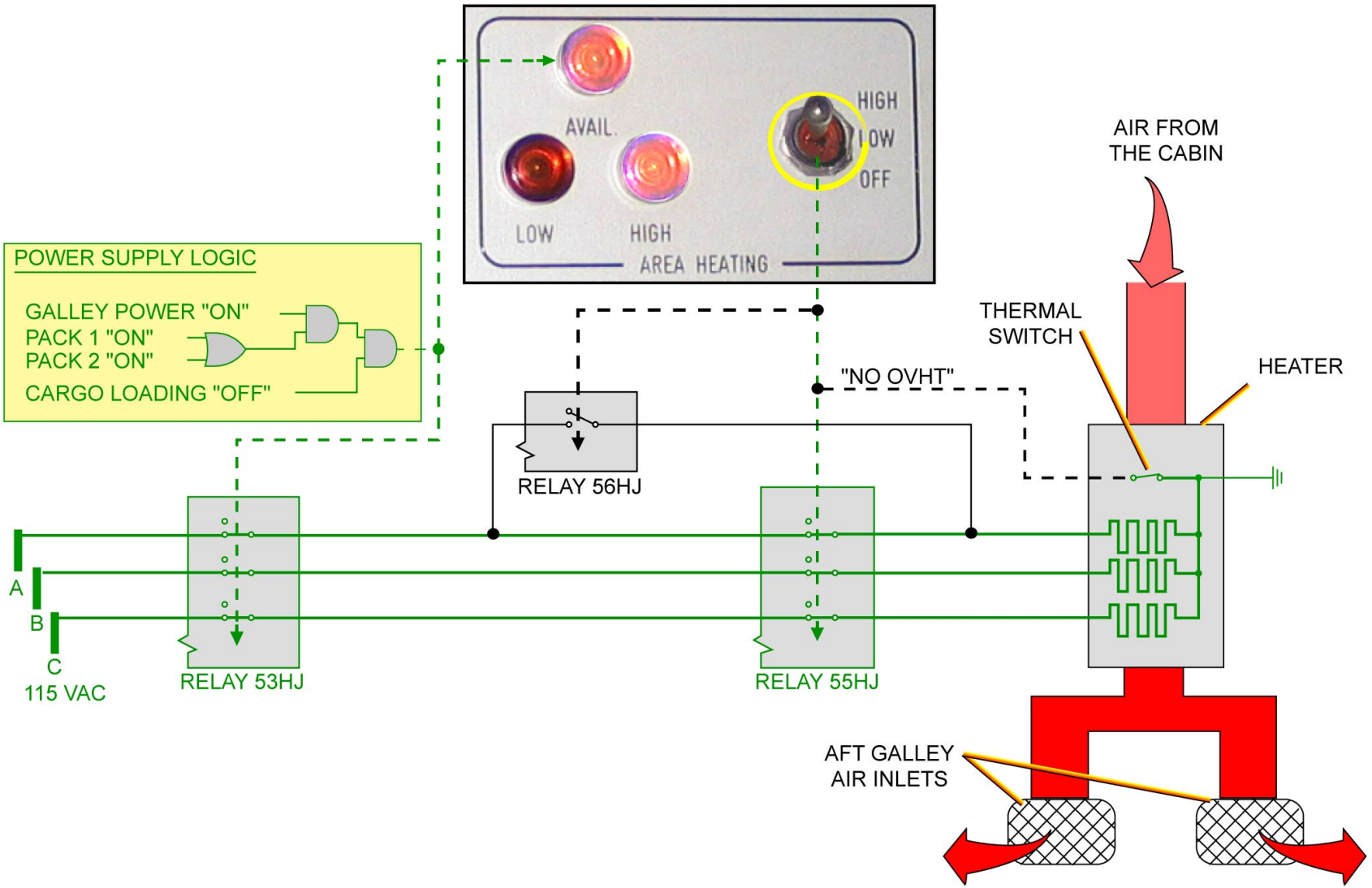
G9409341 - GAUT0T0 - FM21DJ000000001

AFT GALLEY HEATING D/O (3)

CONTROL AND INDICATING

As soon as all the heater supply initial conditions are fulfilled, the "AVAIL" indication illuminates on the aft GALLEY AREA HEATING panel meaning that the heater is available.
Two temperature settings (LOW or HIGH) can be selected through two p/b switches located on the GALLEY AREA HEATING panel.
The "LOW ON" selection powers one heating element while the "HIGH ON" selection powers the three elements.

G9409341 - GAUT0T0 - FM21DJ000000001



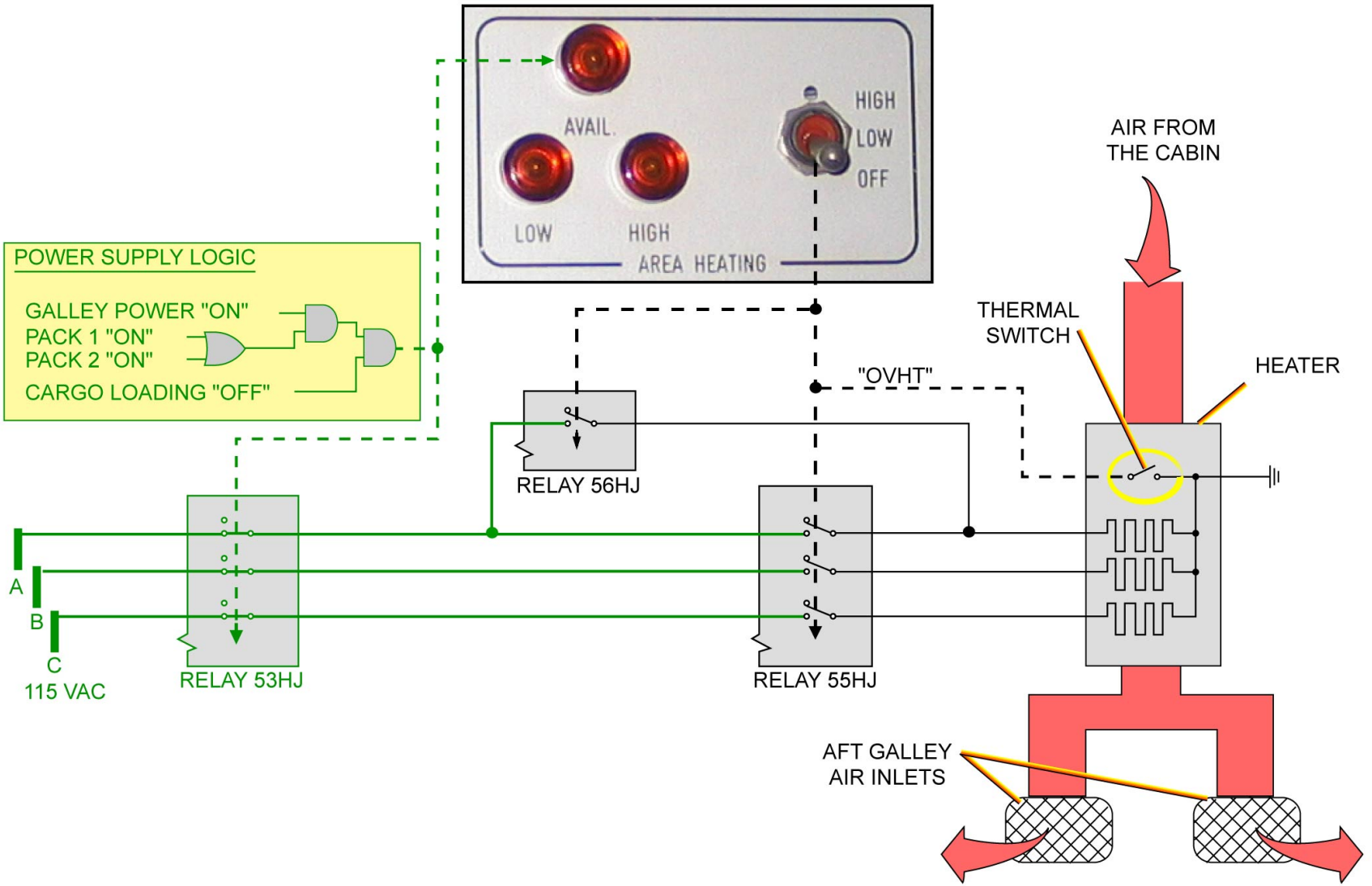
CONTROL AND INDICATING

AFT GALLEY HEATING D/O (3)

THERMAL PROTECTION

In case of heater overheat the thermal switch opens. This causes the heater supply to be interrupted. The "AVAIL" indication on the GALLEY AREA HEATING panel will extinguish as long as the overheat exists.

G9409341 - GAUT0T0 - FM21DJ000000001



THERMAL PROTECTION

G9409341 - GAUT0T0 - FM21DJ000000001

FWD CARGO COMPT VENT/TEMP CTL SYSTEM D/O (3)

GENERAL

The forward cargo compartment is ventilated by cabin air, cooled by cold air from pack 2 and heated by hot air from trim air Pressure Regulating Valve (PRV) 1. The temperature of the forward cargo compartment is controlled from the overhead panel in the cockpit.

INLET ISOLATION VALVES

The inlet isolation valves allow cabin air, from openings in the cabin floor, to enter the compartment. Control is achieved, via the Ventilation Controller (VC), by the ISOLation VALVES P/BSW. To isolate the cargo compartment, the isolation valves close if DITCHING is selected or if smoke is detected in the compartment.

TRIM AIR VALVE

Heating regulation is achieved by a trim air valve, which allows hot air to be mixed with cabin air. The VC controls the trim air valve through a stepper motor according to cockpit control selection.
The trim air valve closes if:
- the FWD cargo compartment door is opened from the Proximity Switch Control Unit (PSCU),
- the extraction fan is inoperative,
- duct overheat is detected,
- FWD cargo smoke is detected by the Smoke Detector Control Unit (SDCU),
- there is no hot air supply when trim air PRV 1 and trim air Shut-off Valve (SOV) closed, from the Zone Controller (ZC).

COLD AIR VALVE

Cooling regulation is achieved by a cold air valve, which allows cold air to be mixed with cabin air. The cold air valve is controlled by the VC according to the cockpit cooling selector position.
The valve closes in case of:
- ISOL VALVES or COOLING OFF selection,
- DITCHING configuration,
- both flow control valves closed,
- FWD cargo smoke warning,
- extraction fan inoperative,
- one isolation valve closed.

When NORMal or MAXimum is selected, the ZC receives signals to increase the flow delivered by the pack flow control valves.

OUTLET ISOLATION VALVE

The outlet isolation valve allows air to be sent overboard via the FWD outflow valve. Control is achieved, via the VC, by the ISOL VALVES P/BSW. To isolate the cargo compartment, it closes if DITCHING is selected or if smoke is detected in the FWD cargo compartment.

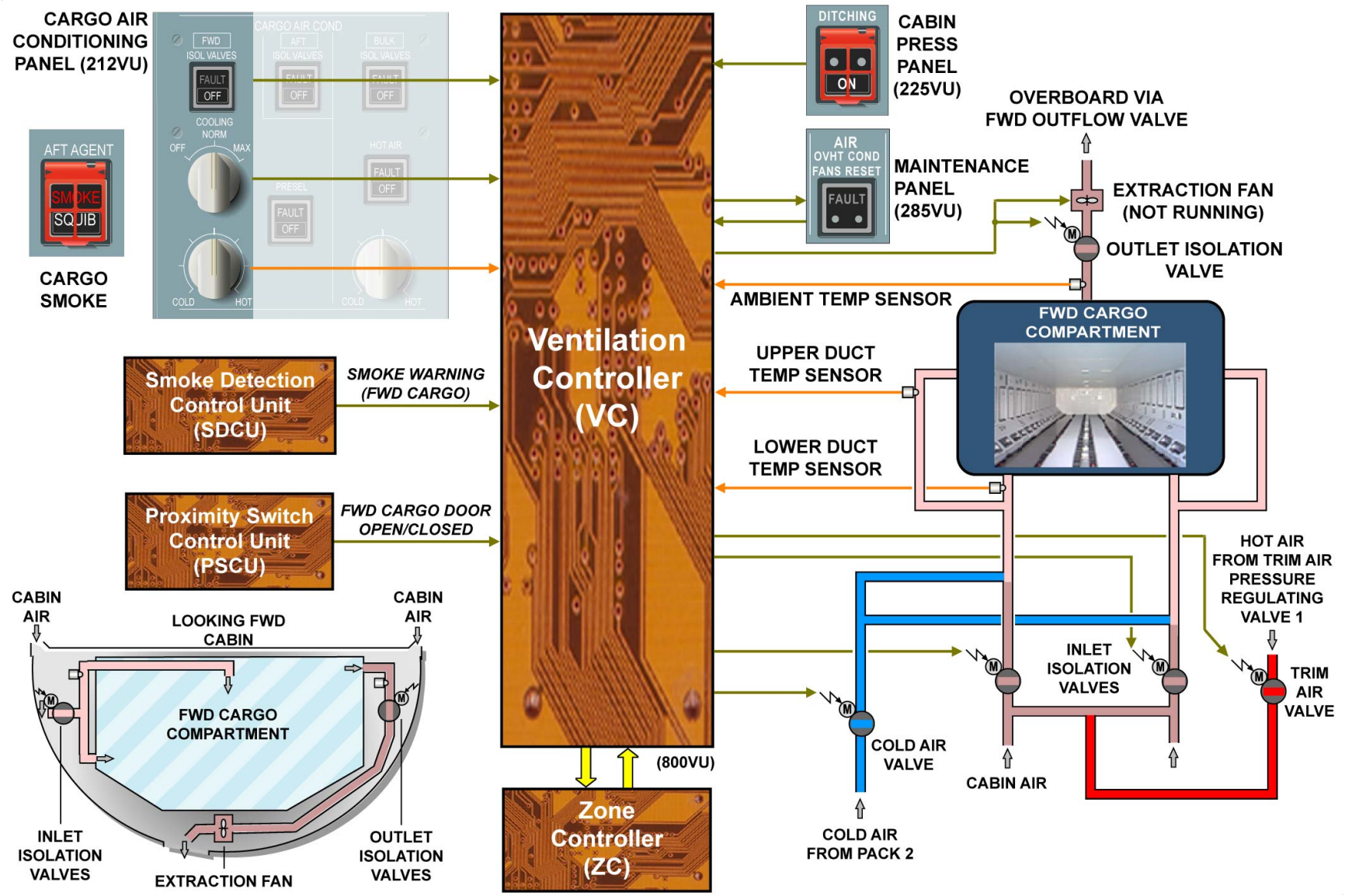
EXTRACTION FAN

The two-speed extraction fan extracts the FWD cargo compartment air. It operates provided normal or max cooling is selected and both flow control and isolation valves are open. High speed is only used when NORM or MAX cooling is selected, and both pack flow control valves and isolation valves are open.

TEMPERATURE SENSORS

Two dual duct temperature sensors and one dual compartment temperature sensor send temperature signals to the VC for temperature control and duct overheat detection. The VC sends a FWD cargo duct overheat signal to the ZC in order to close the trim air PRV 1 and the trim air SOV, if open.

G9409341 - GAUT0T0 - FM21DH000000001



GENERAL ... TEMPERATURE SENSORS

AFT CARGO COMPARTMENT VENTILATION D/O (3)

GENERAL

The aft cargo compartment is ventilated with cabin air.

INLET ISOLATION VALVES

The inlet isolation valves allow cabin air, from openings in the cabin floor, to enter the compartment. Control is achieved, via the ventilation controller, by the ISOL VALVES pushbutton switch.
To isolate the cargo compartment, they close if DITCHING is selected or if smoke is detected in the aft or bulk cargo compartment.

EXTRACTION FAN

The extraction fan extracts the air from the cargo compartment.
The extraction fan operates provided at least one inlet isolation valve is open and the outlet isolation valve is open. It stops if smoke detected in the aft or bulk cargo compartment.

OUTLET ISOLATION VALVE

The outlet isolation valve allows the air to be ducted overboard through the aft outflow valve. Control is achieved, via the ventilation controller, by the ISOL VALVES pushbutton switch.
To isolate the cargo compartment, it closes if DITCHING is selected or if smoke is detected in the aft or bulk cargo compartment.

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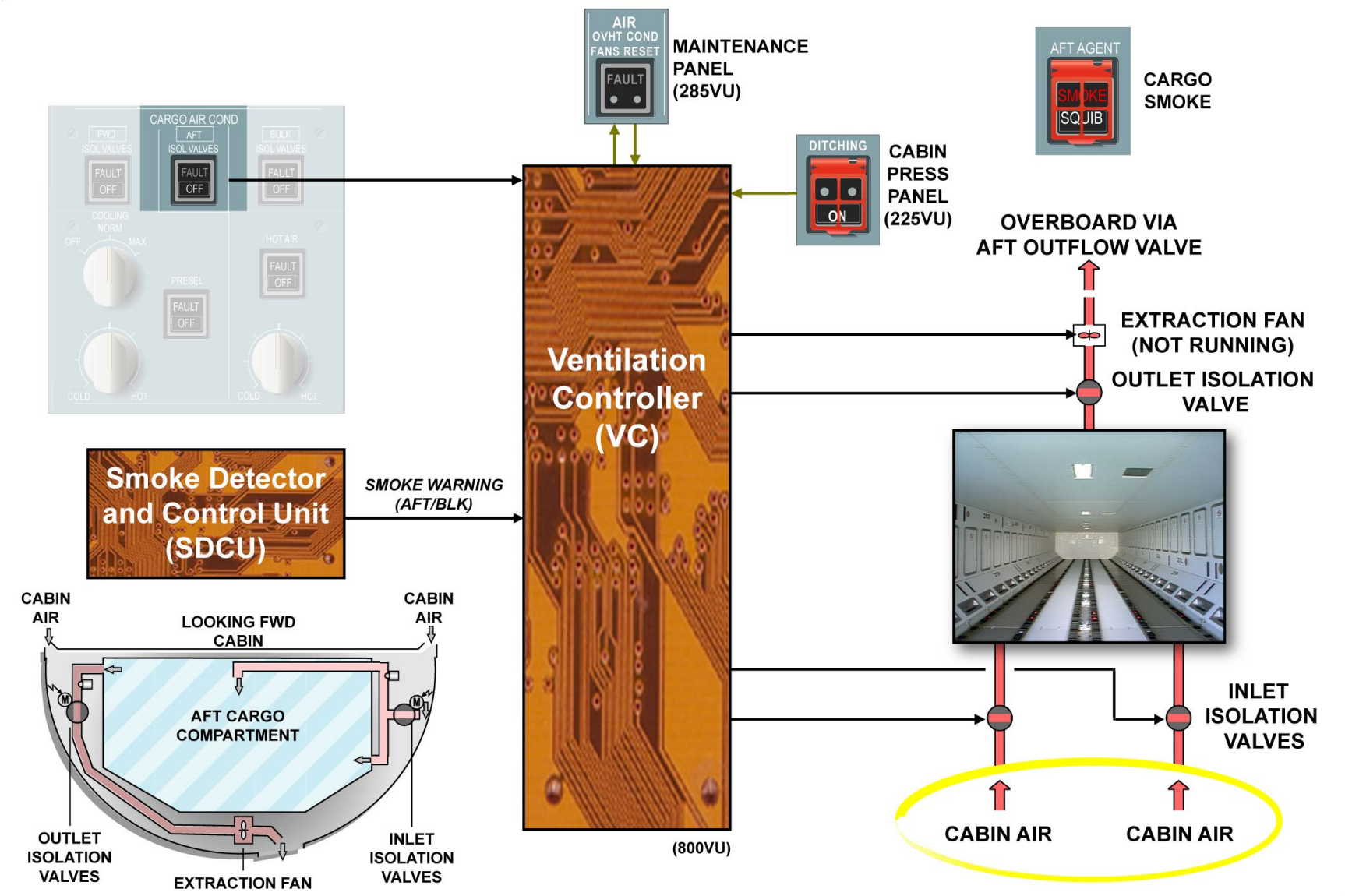


GENERAL ... OUTLET ISOLATION VALVE

G9409341 - GAUT0T0 - FM21DK000000001

BULK CARGO COMPT VENT/HEATING D/O (3)

SYSTEM DESCRIPTION

The system performs the:
- bulk cargo compartment ventilation control and monitoring,
- bulk cargo compartment heating control and monitoring,
- bulk cargo compartment component monitoring,
- abnormal/degraded operation handling.

VENTILATION CONTROLLER (VC)

The Ventilation Controller (VC) contains two independent computer lanes, each of which is able to perform all control, monitoring and BITE functions. One of these lanes is designated as being "active" while the other lane remains in a passive "hot-standby" mode. An automatic changeover occurs at the end of each flight or during the flight, if there is a failure in the active lane. Should a fault exist in both lanes, active control will be passed to the lane with the least significant fault. A covered RS232 test equipment connector is fitted to the controller. The VC provisions are defined through pin programming.

ISOLATION VALVES

Each isolation valve is a shut-off butterfly valve. It is mechanically actuated by a 28V DC motor and electrically controlled from the VC. The valve has two positions and is fitted with two limit switches for Fully Closed (FC)/Fully Open (FO) position detection. The valve also has a thermal overheat protection. A manual lever shows the valve position and makes manual overriding possible.

EXTRACTION FAN

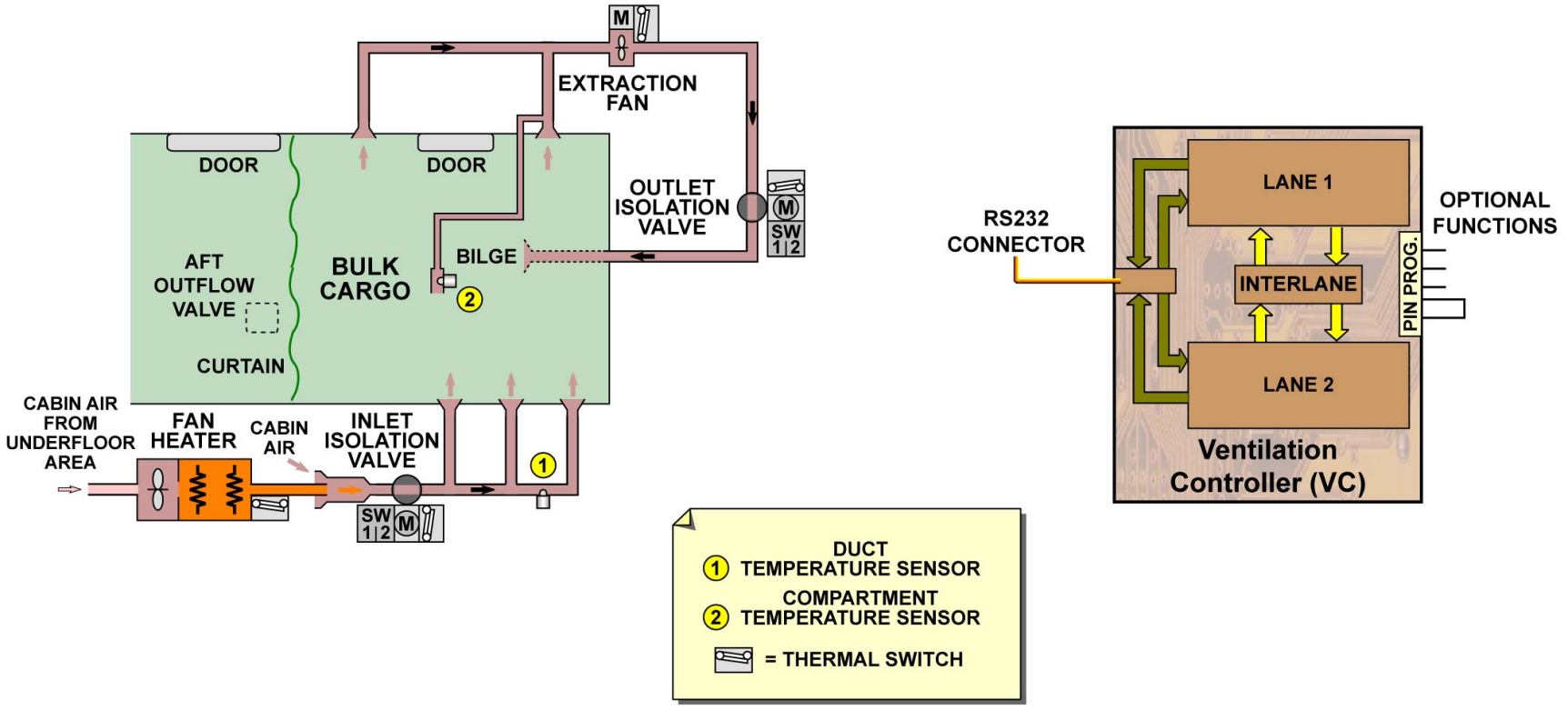
The bulk cargo compartment extraction fan is a single speed fan. It is driven by a three-phase induction motor and controlled from the VC. Thermal switches are installed to stop the electrical power supply to the induction motor if the temperature increases to 140 °C (284 °F) or more.

FAN HEATER

For the bulk cargo compartment heating, an electrical fan heater is installed in the inlet duct of the bulk ventilation system. The fan heater has two three-phase electrical heater element blocks and a three-phase motor. The motor drives a fan wheel that causes air to flow through the fan heater. The temperature control function and the equipment monitoring is done by the VC according to the cockpit panel selection. The heater elements are power supplied by 115V AC. Thermal switches ensure overheat protection by cutting off the power supply to the elements.

DUCT/COMPARTMENT TEMPERATURE SENSORS

Two sensors measure the air temperature throughout the system. The duct temperature sensor (1) measures the air temperature in the inlet duct. The compartment temperature sensor (2) measures the air temperature at the compartment ceiling. Both sensors are double element-sensing units of the thermistor type. They give duct and compartment temperature feedback to the VC for heating control, temperature monitoring and indicating.



SYSTEM DESCRIPTION - VENTILATION CONTROLLER (VC) ... DUCT/COMPARTMENT TEMPERATURE SENSORS

G9409341 - GAUT0T0 - FM21DACRGBULK02

BULK CARGO COMPT VENT/HEATING D/O (3)

VENTILATION SYSTEM NORMAL OPERATION

The VC automatically controls the ventilation system. In normal conditions, the VC controls both isolation valves to open provided the BULK ISOLation VALVES P/BSW is pressed in. As soon as the isolation valves are FO, the VC switches on the extraction fan power supply. The VC monitors:
- the position of the isolation valves,
- the extraction fan power feedback.

HEATING SYSTEM NORMAL OPERATION

The VC automatically controls the heating system. In normal conditions, the VC switches on the fan heater power supply, provided the HOT AIR P/BSW is pressed in. The VC triggers bulk air heating if:
- the isolation valves are FO,
- the compartment temperature is lower than the selected temperature.

The VC defines a required heating performance based on:
- the selected temperature,
- the compartment temperature,
- the fan heater temperature.

The VC controls one heater-element block with a pulse-width-modulated signal. It gives a continuous heating performance between 0 and 3 kW. If the required heating performance exceeds this value, the VC switches on a second block with a constant performance of 3 kW, thus allowing a continuous performance between 0 and 6 kW.
The VC monitors:
- the duct temperature,
- the compartment temperature,
- the fan heater power feedback.

VENTILATION SYSTEM ABNORMAL/DEGRADED OPERATION

The bulk cargo compartment ventilation is shut down in case of:
- manual ventilation off command,
- smoke warning,
- ditching,
- emergency configuration,
- isolation valve failed closed,
- fan failure,
- fan overheat.

MANUAL VENTILATION OFF COMMAND

As soon as the BULK ISOL VALVES P/BSW is released out, the OFF light comes on. The VC stops the extraction fan and controls both isolation valves to close until they have reached their FC position.

SMOKE WARNING

When the Smoke Detection Control Unit (SDCU) triggers an AFT/BULK smoke warning, the VC automatically closes both isolation valves and the extraction fan stops.

DITCHING

When the DITCHING P/BSW is set to ON, a discrete signal is sent to the VC to close the isolation valves.

AIRCRAFT EMERGENCY CONFIGURATION

Two electrical aircraft emergency configuration signals coming from a relay logic are used to stop the extraction fan and the fan heater.

VALVE POSITION DISAGREEMENT

When any isolation valve position disagrees with the command, the VC triggers the FAULT light on the BULK ISOL VALVES P/BSW. The VC also triggers an ECAM warning message on the EWD. The

G9409341 - GAUT0T0 - FM21DACRGBULK02

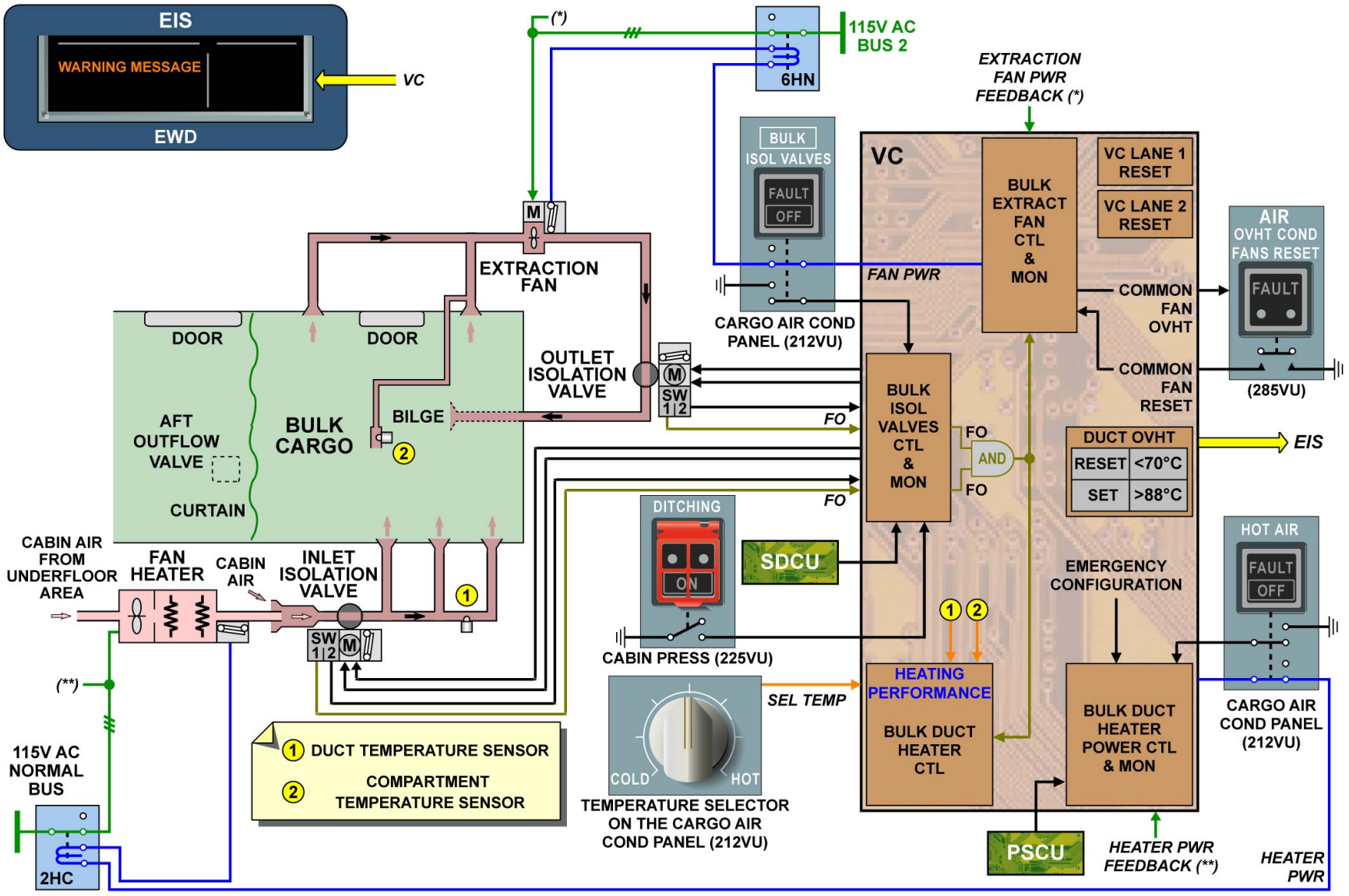
extraction fan is automatically switched off if at least one isolation valve has failed closed.

FAN FAILURE

If no power feedback is received, the VC switches off the extraction fan and triggers an ECAM warning message on the EWD.

FAN OVERHEAT/RESET

If there is a fan overheat, the FAULT light on the OVerHeaT CONDition FANS RESET P/BSW comes on and the extraction fan stops. If the overheat has gone, the extraction fan can be reset by pushing the OVHT COND FANS RESET P/BSW. As a consequence, the FAULT light goes off and the extraction fan starts again.



VENTILATION SYSTEM NORMAL OPERATION ... VENTILATION SYSTEM ABNORMAL/DEGRADED OPERATION

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BULK CARGO COMPT VENT/HEATING D/O (3)

HEATING SYSTEM ABNORMAL/DEGRADED OPERATION

The heating system stops in case of:
- manual heating off command,
- bulk cargo door opening,
- ventilation not operative,
- emergency configuration,
- fan heater failure,
- duct overheat.

MANUAL HEATING OFF COMMAND

As soon as the HOT AIR P/BSW is released out, the OFF light comes on and the VC switches off the fan heater power supply.

BULK CARGO DOOR OPENING

As long as the Proximity Switch Detection Unit (PSCU) detects a bulk cargo door open, the VC stops the fan heater operation.

VENTILATION NOT OPERATIVE

As long as one of the two isolation valves are Not Fully Open (NFO), the VC stops the fan heater operation.

EMERGENCY CONFIGURATION

If the A/C is in an emergency configuration (loss of all four main AC bus bars), the VC switches off the fan heater power supply.

FAN HEATER FAILURE

If no power feedback is received, the VC switches off the fan heater power supply and triggers an ECAM warning message on the EWD.

DUCT OVERHEAT

A duct overheat condition is set as soon as the duct temperature, sensed by the duct temperature sensor (1), rises above 88°C. The VC latches the duct overheat condition and automatically switches off the fan heater power supply. The VC will trigger:
- a FAULT light on the HOT AIR P/BSW,
- an ECAM warning message on the EWD,
- an amber duct temperature indication on the ECAM COND page.

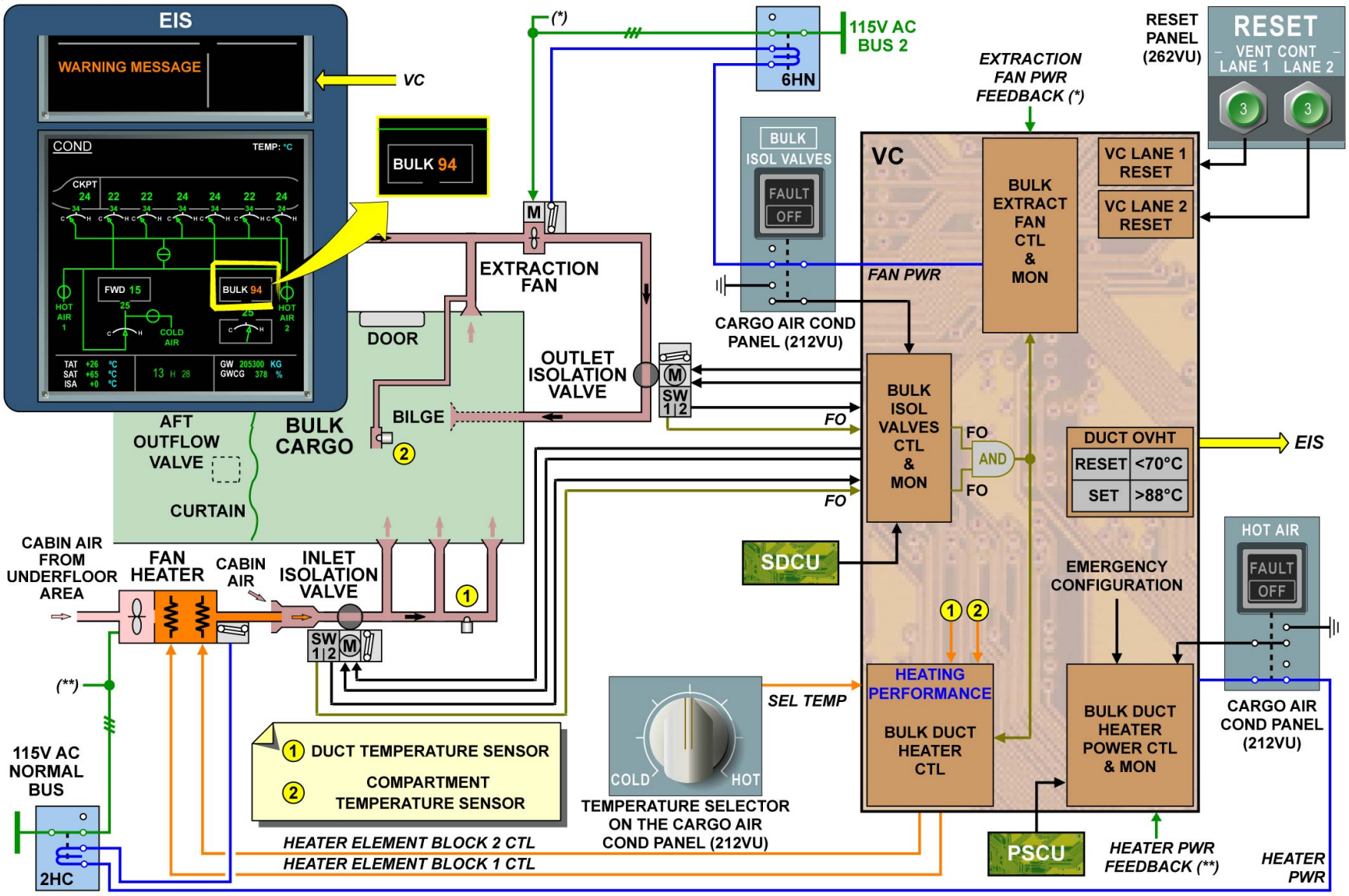
Provided the duct temperature drops below 70°C, the duct overheat can be reset by using the HOT AIR P/BSW. When the HOT AIR P/BSW set to OFF, the FAULT light on the HOT AIR P/BSW goes off and the fan heater is enabled to start again.

VC FAILURE

All control and monitoring functions remain if one lane has failed. The other lane takes over and triggers:
- an ECAM warning message on the EWD,
- an amber VC lane indication on the ECAM COND page.

The faulty VC lane can be reset from the dedicated VENT CONT LANE reset button located on the RESET panel.
A full VC failure or VC power supply loss leads to the extraction fan and fan heater shutdown but the isolation valves remain in their last position. Indications about the bulk cargo compartment heating system are no longer available on the ECAM COND page. Moreover, the EIS triggers an ECAM warning message on the EWD.

G9409341 - GAUT0T0 - FM21DACRGBULK02



HEATING SYSTEM ABNORMAL/DEGRADED OPERATION & VC FAILURE

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PRESSURIZATION SYSTEM D/O (3)

GENERAL

The amount of cabin air discharged overboard is controlled for the cabin pressurization. This is achieved through two outflow valves located on the lower part of the aircraft fuselage. This system can be operated automatically, manually or both.

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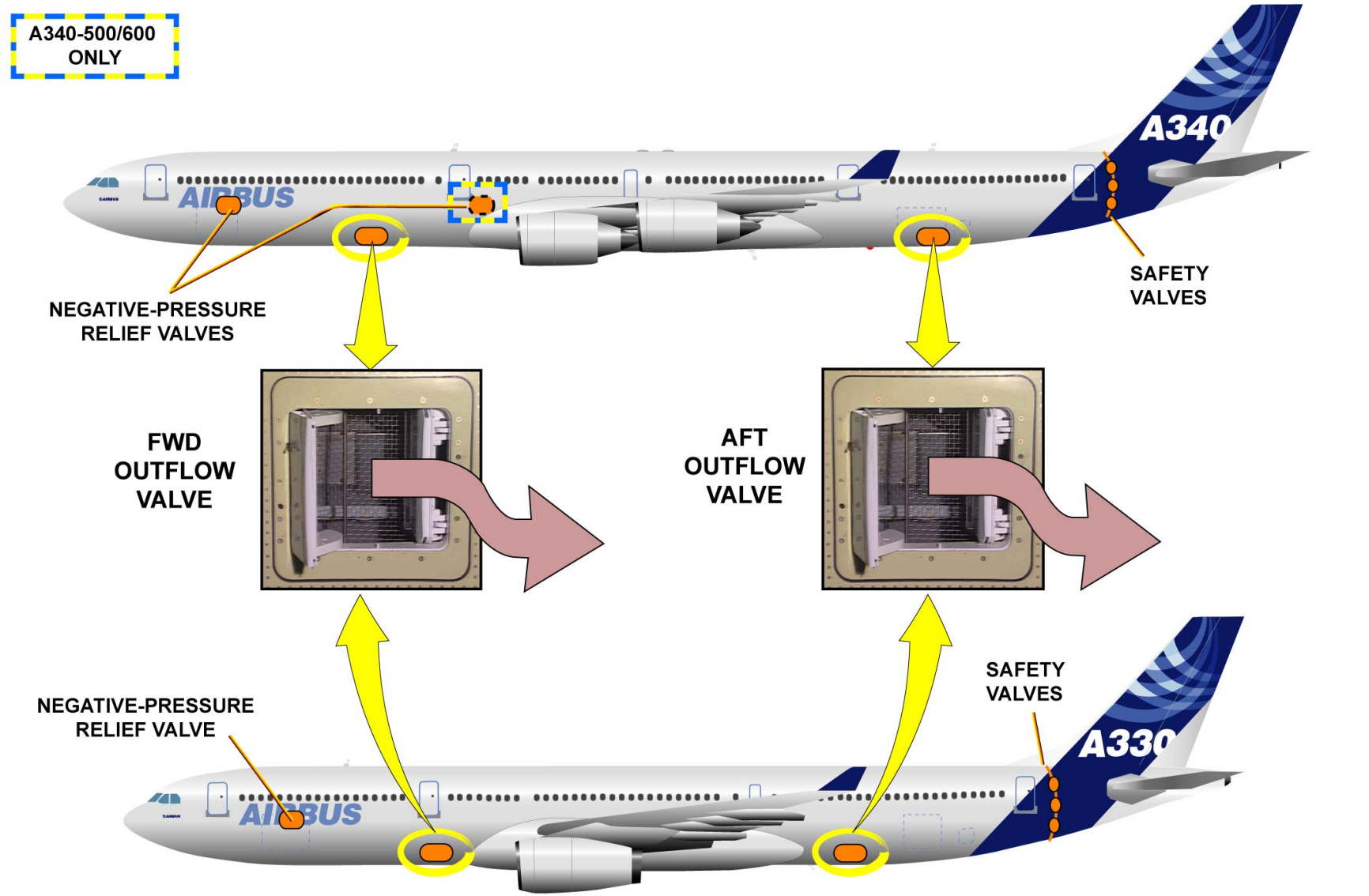
A340-500/600
ONLY
A340
AIRBUS
NEGATIVE-PRESSURE
RELIEF VALVES
SAFETY
VALVES
FWD
OUTFLOW
VALVE
AFT
OUTFLOW
VALVE
NEGATIVE-PRESSURE
RELIEF VALVE
SAFETY
VALVES
A330
AIRBUS

GENERAL

PRESSURIZATION SYSTEM D/O (3)

GENERAL (continued)

SYSTEM ARCHITECTURE

Each outflow valve can be operated by 3 different systems:
- automatic system 1,
- automatic system 2,
- a manual system.

There are 2 types of safety device which operate independently:
- two negative pressure relief valves for the A340-500/600, one negative pressure relief valve for the A330/A340-200/300, which prevents negative differential pressure in the fuselage. They are mechanically spring-loaded closed valves,
- three safety valves which prevent excessive positive or negative differential pressure in the fuselage installed on the aft pressure bulkhead. The safety valves operate pneumatically.

SYSTEM CONTROLS

In automatic operation, outflow valves are alternatively operated by system 1 or system 2. The Cabin Pressure Controller 1 (CPC 1) controls the System 1. The CPC 2 controls the System 2.
There are 2 automatic modes:
- the external mode pressurizes the cabin according to the Flight Management Guidance and Envelope System (FMGES) data during climb and descent. It optimizes passenger comfort,
- the internal mode pressurizes the cabin according to ambient parameters.

The CPCs automatically close both outflow valves in case of ditching selection.
In manual operation, the manual system is controlled from the CABIN PRESSurization panel. It is activated when the MODE SELection P/BSW is selected to the MANual ON position. The outflow valves can be simultaneously or independently selected through the VALVE SEL switch and operated by action on the Vertical/Speed ConTroL toggle switch.

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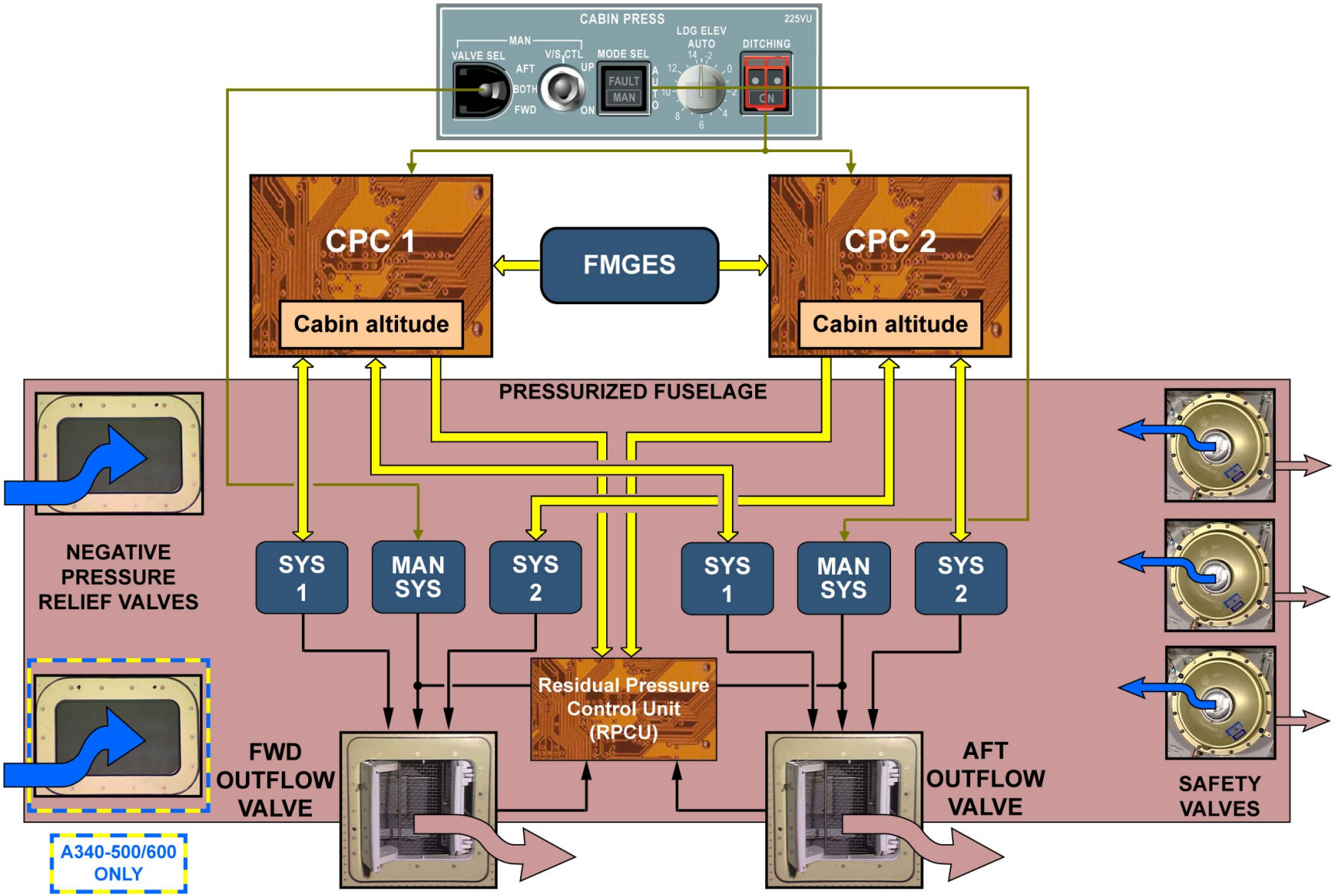

GENERAL - SYSTEM ARCHITECTURE & SYSTEM CONTROLS

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PRESSURIZATION SYSTEM D/O (3)

GENERAL (continued)

SYSTEM MONITORING

The CPCs monitor the position of the outflow valves and safety valves. The valve position indications are shown on the ECAM CAB PRESS page. Automatic system failures are displayed on the MODE SEL P/BSW.

NOTE: The three safety valves are monitored by the CPC's.

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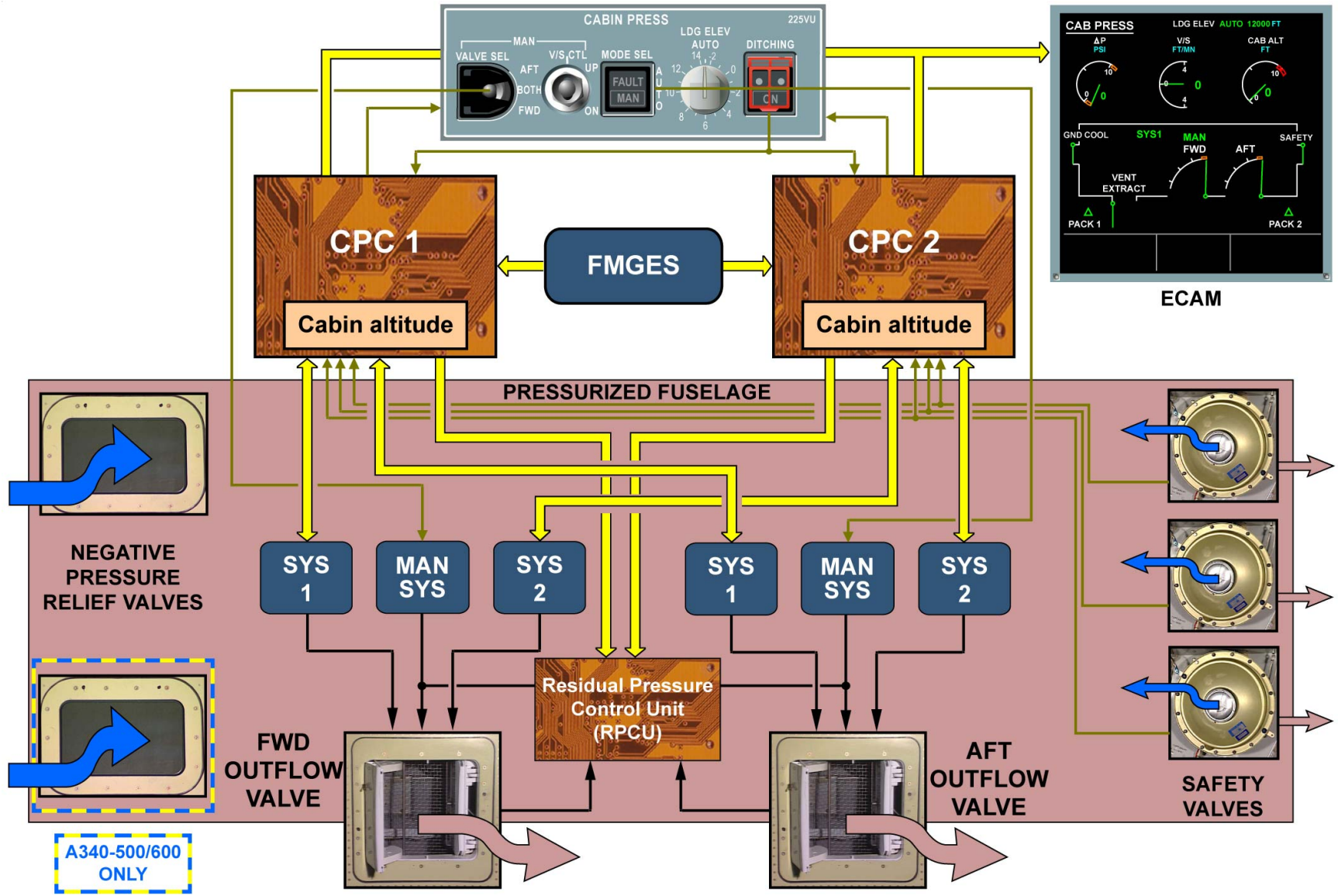

GENERAL - SYSTEM MONITORING

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PRESSURIZATION SYSTEM D/O (3)

CPC

There are two interchangeable controllers, which are identified as CPC 1 and CPC 2 by means of a pin programming. Each controller has an automatic and manual part which are functionally and electronically independent of each other. One controller operates the system at a time according to flight profile data and A/C configurations. The second controller is in active stand- by with automatic change over after each flight or in case of failure of the active one.
The CPCs inputs are:
- flight profile data: FMGES, Air Data/Inertial Reference System (ADIRS) and Onboard Maintenance System (OMS),
- A/C configurations: Engine Interface and Vibration Monitoring Unit (EIVMU), Landing Gear Control and Interface Unit (LGCIU), Proximity Switch Control Unit (PSCU) and Environmental Control System (ECS).
The CPCs outputs data for indicating and monitoring are: ECAM, ECS and OMS.
When manual mode is used, the manual part of controller 1 operates only as a back-up indication circuit processing outputs for indicating and monitoring. CPC 1 manual part outputs for monitoring and indicating are: ECAM, ECS and OMS. CPC 2 manual part is not used.

OUTFLOW VALVES

The operating controller controls the outflow valves in automatic mode. The two outflow valves are of the double flap and motor driven type. Depending on the operating controller, electrical motor 1 or motor 2 operate each outflow valve:
- motor 1 is controlled by controller 1,
- motor 2 is controlled by controller 2.
Two electronic actuators carry out the interface with the controllers. A pressure switch, which operates independently from the automatic mode, is installed in each electronic actuator. It closes the applicable outflow valve in case of cabin altitude above 15000 ft. Motor 3 is controlled from the CABIN PRESS panel by the MAN V/S CTL toggle switch when manual mode is selected on the MODE SEL P/B.
Both valves may be independently or simultaneously selected by use of the ACTIVE VALVE selector. If only one outflow valve is manually selected, the other one remains under the active CPC control (mixed mode). The corresponding electronic actuator uses automatic mode signal. Manual mode feedback (N°3) signal is directly sent to controller 1 manual part for outflow valve position indication. Controller 2 manual part is not used.

SAFETY VALVES

The safety valves prevent excessive positive and negative differential pressure in the fuselage. They open when the differential pressure exceeds 8.85 psi or goes below -1 psi. They are installed on the rear pressure bulkhead above the A/C flotation line.

NEGATIVE PRESSURE RELIEF VALVE

The negative pressure relief valve helps the safety valves to prevent negative differential pressure in the cabin. It shall start to open between -0.26 and -0.36 psi. It is installed below the floor level aft of left door number 1, above the floating line. The second valve only installed on the A340-500/600 is located below the floor level aft of right door number 2, also above the floating line.

RESIDUAL PRESSURE CONTROL UNIT (RPCU)

The Residual Pressure Control Unit (RPCU) takes over the control of the outflow valves automatically if one or both outflow valves are not in the fully open position when the aircraft is on ground. This is to prevent any door violent opening in case of residual cabin pressure. The RPCU opens each outflow valve via its manual motor when:
- the outflow valve is not fully open, and

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- both CPCs have failed, or the manual mode is selected,
- the aircraft is on ground,
- and all engines are shutdown, or all ADIRS indicate an airspeed below 100 knots.

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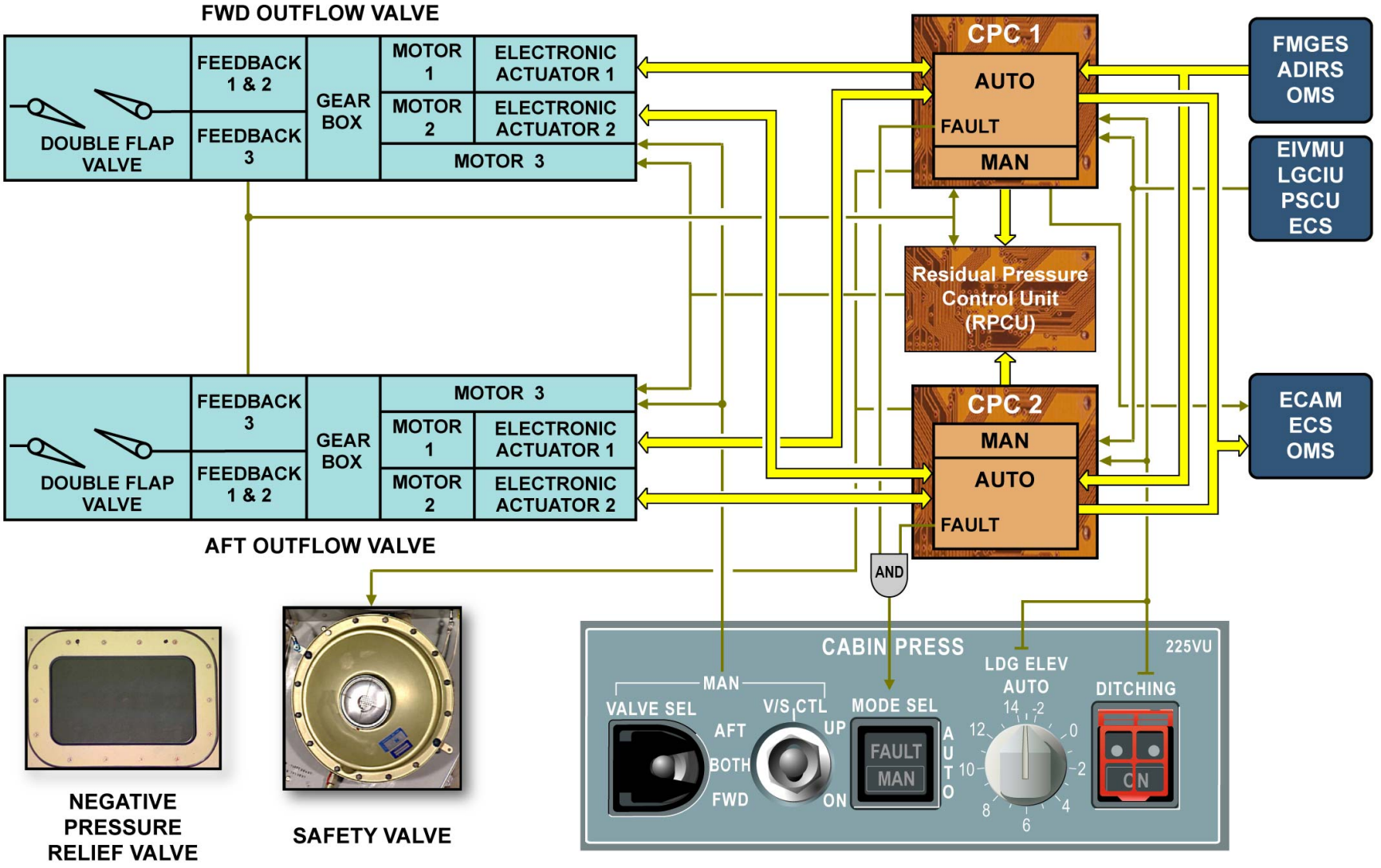

CPC ... RESIDUAL PRESSURE CONTROL UNIT (RPCU)

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PRESSURIZATION SYSTEM D/O (3)

CABIN PRESSURE ALTITUDE ENVELOPE

The A340 normal cabin altitude is limited to 7350 ft with a differential pressure of 8.60 psi for an A/C altitude of 41000 ft. The A330 normal cabin altitude depends on the flight duration. It is limited for an A/C altitude of 41000 ft to:
- 8000 ft, with a differential pressure of 8.32 psi for flights shorter than 2.5 hours,
- 7350 ft, with a differential pressure of 8.60 psi for flights longer than 2.5 hours.

If the cabin altitude reaches 9550 ft, the master warning comes on, and at 11300 ft, passenger signs are activated. In each outflow valve, a safety device closes the valve when the cabin altitude reaches 15000 ft.

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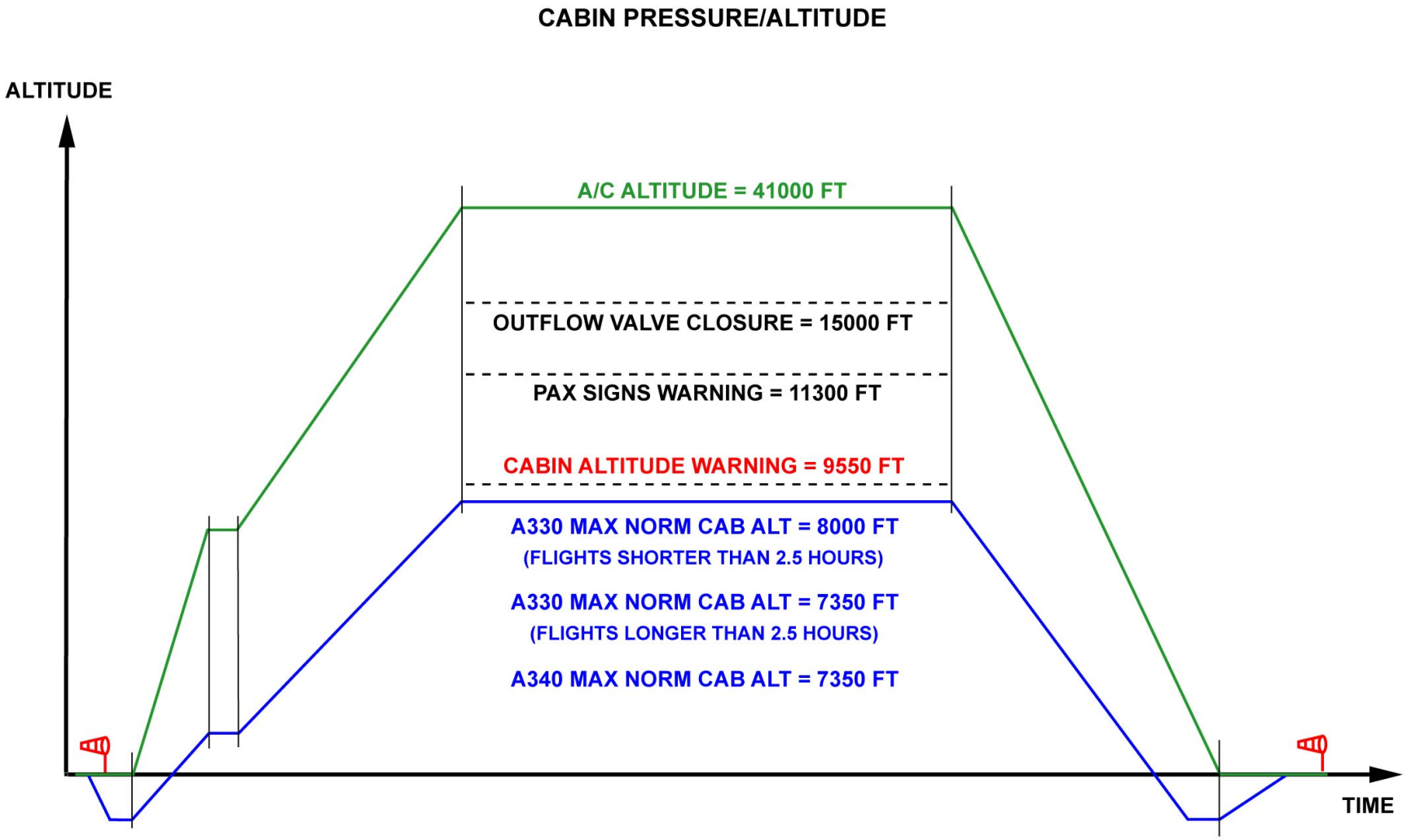
CABIN PRESSURE/ALTITUDE
ALTITUDE
A/C ALTITUDE = 41000 FT
OUTFLOW VALVE CLOSURE = 15000 FT
PAX SIGNS WARNING = 11300 FT
CABIN ALTITUDE WARNING = 9550 FT
A330 MAX NORM CAB ALT = 8000 FT
(FLIGHTS SHORTER THAN 2.5 HOURS)
A330 MAX NORM CAB ALT = 7350 FT
(FLIGHTS LONGER THAN 2.5 HOURS)
A340 MAX NORM CAB ALT = 7350 FT
TIME

CABIN PRESSURE ALTITUDE ENVELOPE

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PRESSURIZATION SYSTEM D/O (3)

FLIGHT PROFILE

This topic describes the normal operation during a typical flight profile:
- take off altitude: 500 ft (QNH),
- landing altitude: 800 ft.

The Landing Field Elevation (LFE) must be set to AUTO position.

NOTE: To display the LFE on the ECAM when the Landing Field Elevation Selector (LFES) is set to AUTO, LFE must be received from the FMGES.

GROUND

On ground, the outflow valves are fully open to make sure that the cabin is depressurized. To indicate the A/C is on ground, a signal is sent when the L/G 1 or 2 is compressed. The Avionics Equipment Ventilation Computer (AEVC) closes the overboard valve and the optional skin valve, when engine 1 or 2 is running for the A330 (engine 2 or 3 for the A340).

TAKE-OFF

The cabin is pre-pressurized as soon as power is set to take off to prevent a pressure surge during rotation. To activate the pre-pressurization, a signal is sent when:
- engine 1 or 2 are set to take off power for the A330 (engine 2 or 3 for the A340),
- main shock absorber 1 or 2 is compressed,
- doors are closed.

The active CPC controls the outflow valves to regulate a fixed cabin rate of descent. The cabin vertical speed (V/S) is 500 ft per minute down until the differential pressure reaches 0.1 psi.

CLIMB

The pressurization is initiated at take-off. The CPC always switches to CLIMB INTERNAL mode for about 30 s to allow the FMGES data validation before going to CLIMB EXTERNAL mode. During this data validation, the FMGES sends, among other things, the remaining flight time to destination to the CPC. This flight duration is computed from the flight plan entered by the crew and used for the maximum normal cabin differential pressure set-up. The active CPC switches to CLIMB INTERNAL when:
- engine 1 or 2 set to take off power for the A330 (engine 2 or 3 for the A340),
- main shock absorbers extended.

After 30 seconds, if FMGES data is validated, the CPC switches to CLIMB EXTERNAL mode.
Pressure control is based on the FMGES inputs taking into account top of climb and planned A/C cruise altitude. During climb the cabin altitude increases at a constant rate, up to the top of climb. Cabin vertical speed is limited to 1000 ft/mn. In case of long level off, the system reverts to CLIMB INTERNAL mode. If FMGES data is not validated, the system will remain in CLIMB INTERNAL mode. This requires the LFE to be set manually. In CLIMB INTERNAL mode, the cabin pressure will follow the ambient pressure evolution according to a proportional schedule. Internal scheduling also makes sure that the maximum cabin differential pressure is not reached during climb.

NOTE: ABORT mode is selected below A/C altitude of 8000 ft if descent rate is higher than 2000 ft/mn for 30 s. The CPC processes an internal schedule in order to land with a differential pressure of 0.1 psi.

CRUISE

The cabin cruise altitude will agree with the highest value computed from A/C planned altitude or actual A/C altitude.

NOTE: The LFE selection takes over from the computed cruise cabin altitude if the LFE is higher.

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DESCENT

The CPC always switches to DESCENT INTERNAL mode for about 30 seconds to allow the FMGES data validation before going to DESCENT EXTERNAL mode. If the FMGES data is validated, the CPC switches to the DESCENT EXTERNAL mode after 30 s. The cabin pressurization profile is computed according to the A/C descent speed, landing altitude, field baro setting and remaining time of arrival. The cabin vertical speed is limited to -750 ft/mn. The CPC computes an ideal constant cabin rate in order to reach an altitude lower than the LFE, before landing.
The cabin altitude goes down below the LFE. Then the cabin altitude remains constant with a differential pressure of 0.1 psi. However, the system will remain in DESCENT INTERNAL mode if the FMGES data is not validated at the top of descent. This requires the LFE to be set manually. The cabin pressurization profile is computed according to the ambient pressure, A/C descent speed, manually selected LFE and landing field baro setting. The cabin vertical speed is limited to -750 ft/mn. The cabin rate is adjusted, so that the cabin altitude reaches the selected LFE plus an offset of 0.1 psi prior to landing. The offset carries out a pressurized landing.

GROUND AFTER LANDING

We are now entering into the depressurization phase. To activate the depressurization, a signal is sent when landing gear 1 or 2 is compressed. The cabin is depressurized at a fixed rate until the differential pressure reaches 0 psi. The rate limiter is overridden and the outflow valves are driven fully open, 70 s after touchdown to make sure that the cabin is fully depressurized. At the same time, a controller change over occurs automatically.

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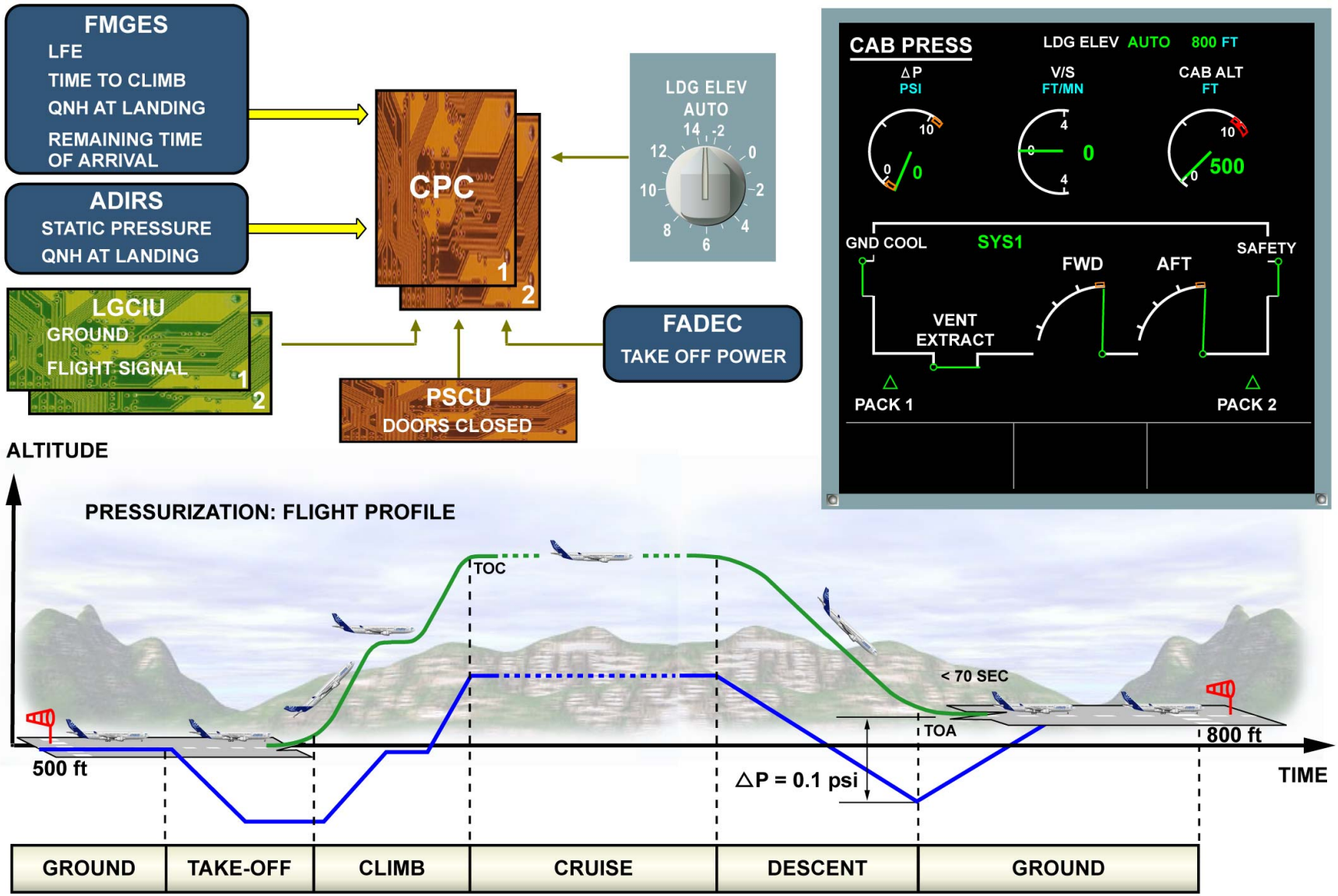

FLIGHT PROFILE - GROUND ... GROUND AFTER LANDING

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AVIONICS EQUIPMENT VENTILATION D/O (3)

GENERAL

The system ensures the ventilation of the avionics equipment in order to guarantee a high reliability level. This is done in compliance with the ARINC 600 requirements. The main items of equipment which are ventilated in the cockpit are:
- the Display Units (DU),
- the Flight Control Unit (FCU),
- the pedestal,
- the overhead panel,
- the cockpit temperature sensor.

The main items of equipment which are ventilated in the avionics compartment are:
- the electronics racks,
- the weather radar shelf,
- the AC/DC power center,
- the forward shelf,
- the Air Data/Inertial Reference Units (ADIRUs),
- the batteries.

The avionics equipment ventilation includes three main subsystems:
- the blowing system,
- the battery ventilation system,
- the extraction system.

BLOWING SYSTEM

The required blowing airflow is bled from the cabin air recirculation system. UNDER NORMAL CONDITIONS the recirculation fans supply the system with the required airflow. The Cooling Effect Detector (CED) ensures permanent monitoring of the cooling capacity of the blowing airflow.

BATTERIES VENTILATION SYSTEM

The batteries are ventilated by an independent sealed circuit. The air extraction is provided by a venturi. The ventilation is only effective with cabin differential pressure.

EXTRACTION SYSTEM

The air used for the avionics equipment ventilation is extracted by means of the extract fan. The air is discharged either to the FWD cargo compartment underfloor through the underfloor valve or overboard through the overboard valve. This system is controlled by the Avionics Equipment Ventilation Computer (AEVC).

EXTRACTION SYSTEM MAIN COMPONENTS

The extraction system is composed of:
- an extract fan,
- an underfloor valve,
- an overboard valve,
- an extract pressure switch.

The fan runs as soon as the aircraft electrical network is powered and remains on as long as electrical supply is available to the motor. The fan is of the one speed, three-phase 115/200V AC-powered type.
The overboard valve is of the skin mounted type. An electrical actuator controls the flap and microswitches detect the three positions of the valve, fully open, partially open and fully closed. A crank fitted on the valve is provided to manually set the valve in the required position.
The underfloor valve is of the butterfly type, electrically controlled by an actuator. Two positions are available: Fully open and fully closed. Microswitches are provided to detect the positions of the valve. A manual lever and visual indicator are provided to operate the valve manually.
The pressure switch monitors the operation of the system. It senses the differential pressure between the cabin and the extraction system.

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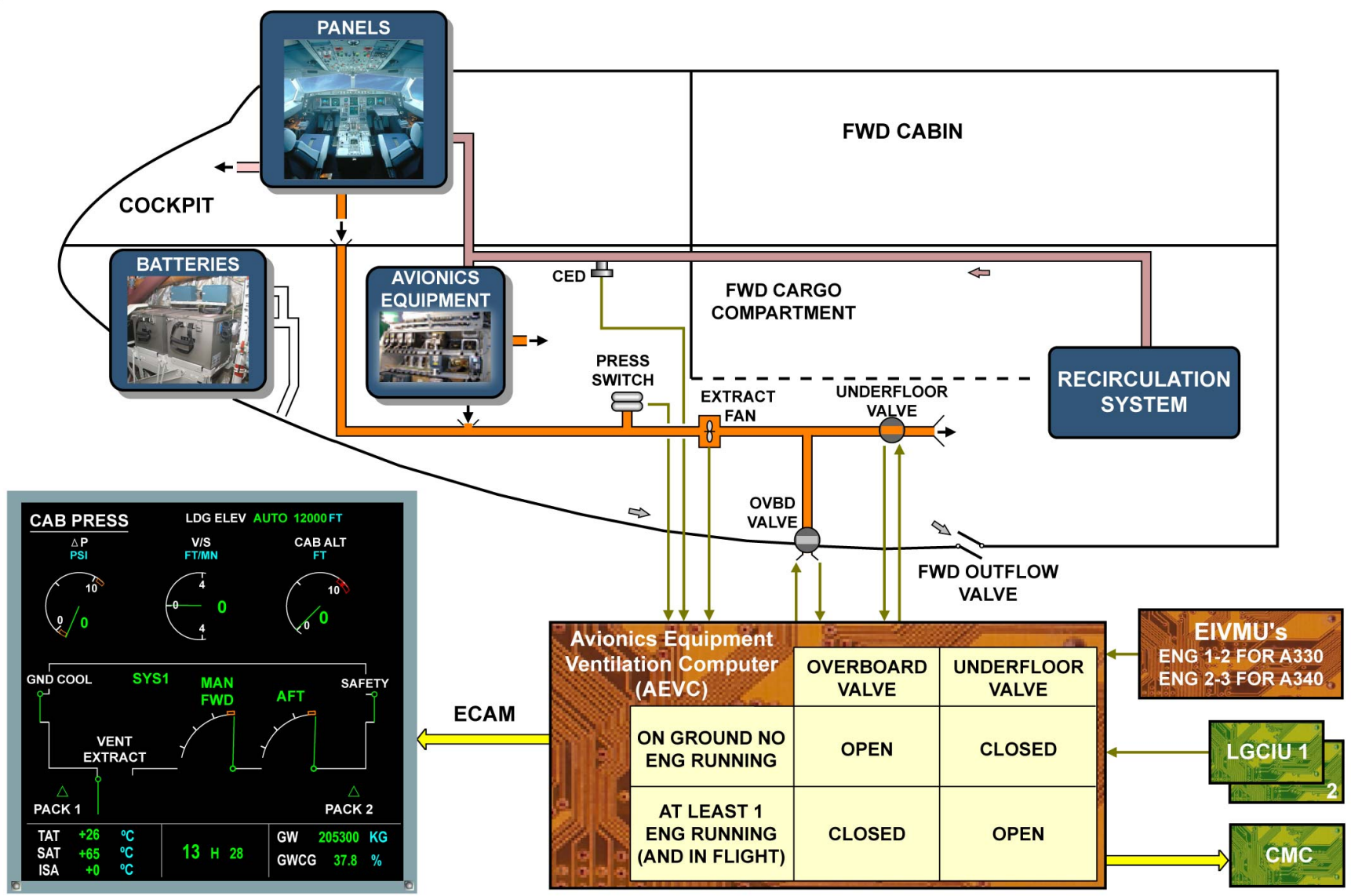
NORMAL OPERATION

On ground with the aircraft electrically supplied, the fan starts to run, the overboard valve is fully open and the underfloor valve is fully closed. Air is extracted overboard. As soon as one engine is running (inboard engines running for the A340), or in flight the overboard valve closes and the underfloor valve opens. Air is extracted underneath the forward cargo floor compartment. Note that the underfloor extract valve can close only if the overboard valve is fully open.
When OVerRiDe is selected, the automatic operation of the system is overridden:
- the overboard valve opens partially,
- the underfloor valve closes,
- the extract fan runs if serviceable. This permits extraction of the air by differential pressure between the cabin and outside in case of a malfunction in the system.

These are the cases of malfunction:
- extract fan failure,
- dispatch of A/C with the overboard valve manually placed in partially open position,
- it is also used for the avionics smoke procedure.



GENERAL ... NORMAL OPERATION

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AVIONICS EQUIPMENT VENTILATION D/O (3)

ABNORMAL OPERATION: VENTILATION FAILURE

In this topic the following abnormal situations are detailed:
- insufficient cooling,
- fan failure,
- overboard valve failure,
- underfloor valve failure.

INSUFFICIENT COOLING

On ground, insufficient cooling detected by the CED activates the following warnings:
- mechanics call horn,
- AVNCS VENT caution light,
- ECAM message.

During flight, in case of insufficient cooling, the CED sends a signal to the AEVC. The AEVC sends a signal to the ECAM.

FAN FAILURE

In case of extract fan failure, the low airflow condition is detected by the pressure switch. A signal is sent to the AEVC. On ground with no engine running, the following warnings are activated:
- mechanics call horn,
- AVNCS VENT caution light,
- ECAM,
- Central Maintenance Computer (CMC),
- FAULT legend on the EXTRACT P/B.

As soon as one engine is running (engine 2 or 3 for the A340), the following warnings are activated:
- FAULT legend on the EXTRACT P/B,
- ECAM,
- CMC.

In case of overheat in the electrical motor of the fan, thermal switches cut off the electrical supply.

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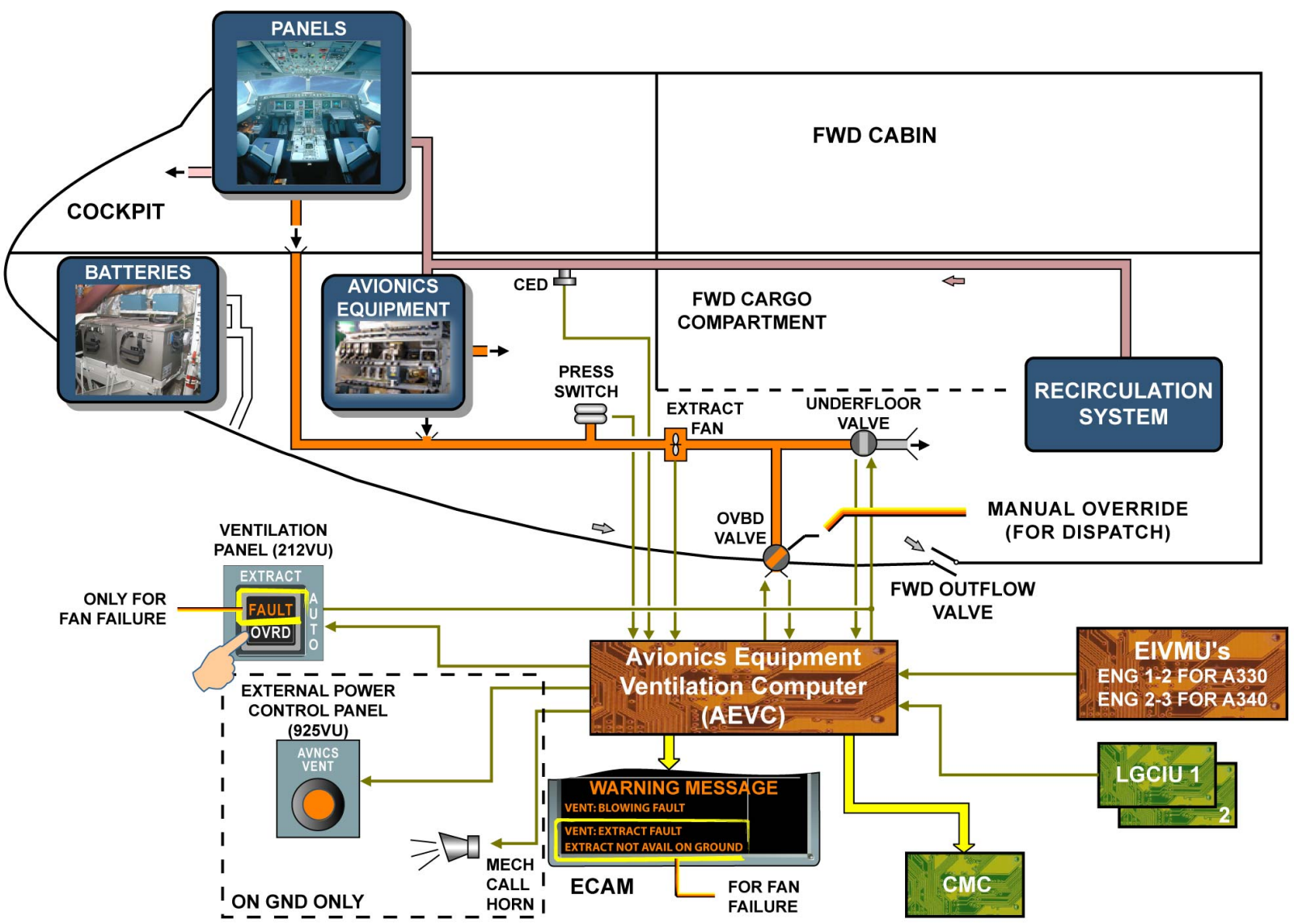

ABNORMAL OPERATION: VENTILATION FAILURE - INSUFFICIENT COOLING & FAN FAILURE

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AVIONICS EQUIPMENT VENTILATION D/O (3)

ABNORMAL OPERATION: VENTILATION FAILURE

OVERBOARD VALVE FAILURE

On ground, at first engine start (engine 2 or 3 start for the A340), if the overboard valve is detected jammed in the open position by the valve microswitches, the following warnings are activated:
- FAULT legend on the EXTRACT P/B,
- mechanics call horn,
- ECAM,
- CMC.

On ground, at both engines shutdown (engines 2 and 3 shut-down for the A340), if the overboard valve is detected jammed in the closed position by the valve microswitches, a warning message is sent to the CMC.

UNDERFLOOR VALVE FAILURE

On ground, at first engine start (engine 2 or 3 start for the A340), if the underfloor valve is detected jammed in the closed position by the pressure switch and the valve microswitches, the following warnings are activated:
- FAULT legend on the EXTRACT P/B,
- ECAM,
- CMC.

On ground, at both engine shutdown (engines 2 and 3 shut-down for the A340), if the underfloor valve is detected jammed in the open position by the microswitches, a warning message is sent to the CMC.
In case of valve positioning failure at engine start, the overboard valve can be partially opened and the underfloor valve closed manually.

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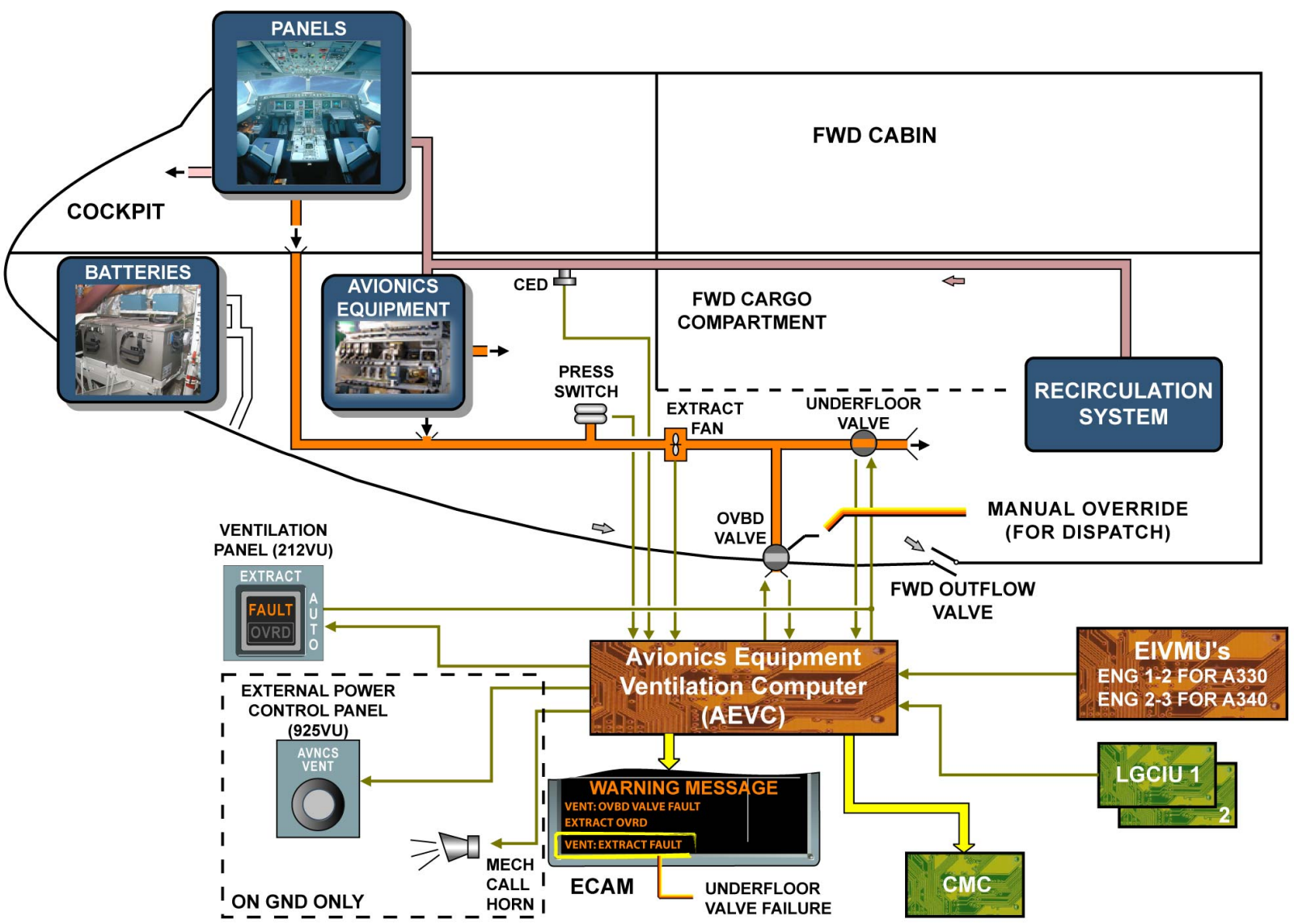

ABNORMAL OPERATION: VENTILATION FAILURE - OVERBOARD VALVE FAILURE & UNDERFLOOR VALVE FAILURE

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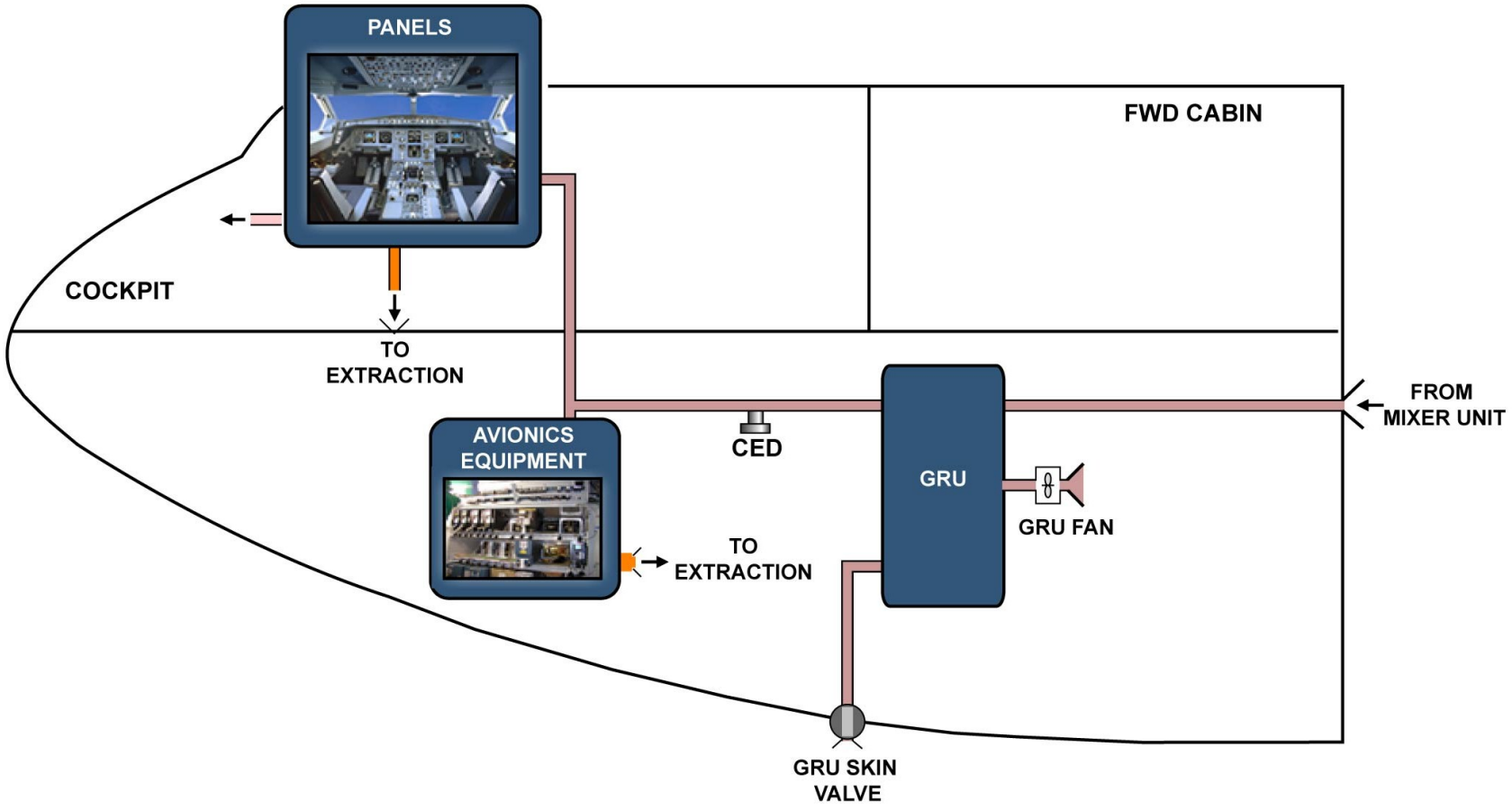
AVIONICS EQUIPMENT GROUND COOLING D/O (OPTION) (3)

GENERAL PRINCIPLE

When operating in hot climates, an optional ground cooling system can be used to provide additional cooling of the avionics equipment.



CED: Cooling Effect Detector

GENERAL PRINCIPLE

AVIONICS EQUIPMENT GROUND COOLING D/O (OPTION) (3)

GENERAL PRINCIPLE (continued)

PRINCIPLE

The air is cooled by a refrigerant-fluid cycle system called the Ground Refrigeration Unit (GRU). The airflow required for the GRU condenser is supplied by the GRU fan in the avionics compartment. The fan blows ambient air from the avionics compartment through the condenser and then overboard, through the GRU skin valve.

MAIN COMPONENTS

The avionics equipment GND cooling system includes these components:
- a GRU fan,
- a GRU,
- a GRU skin valve.

FAN

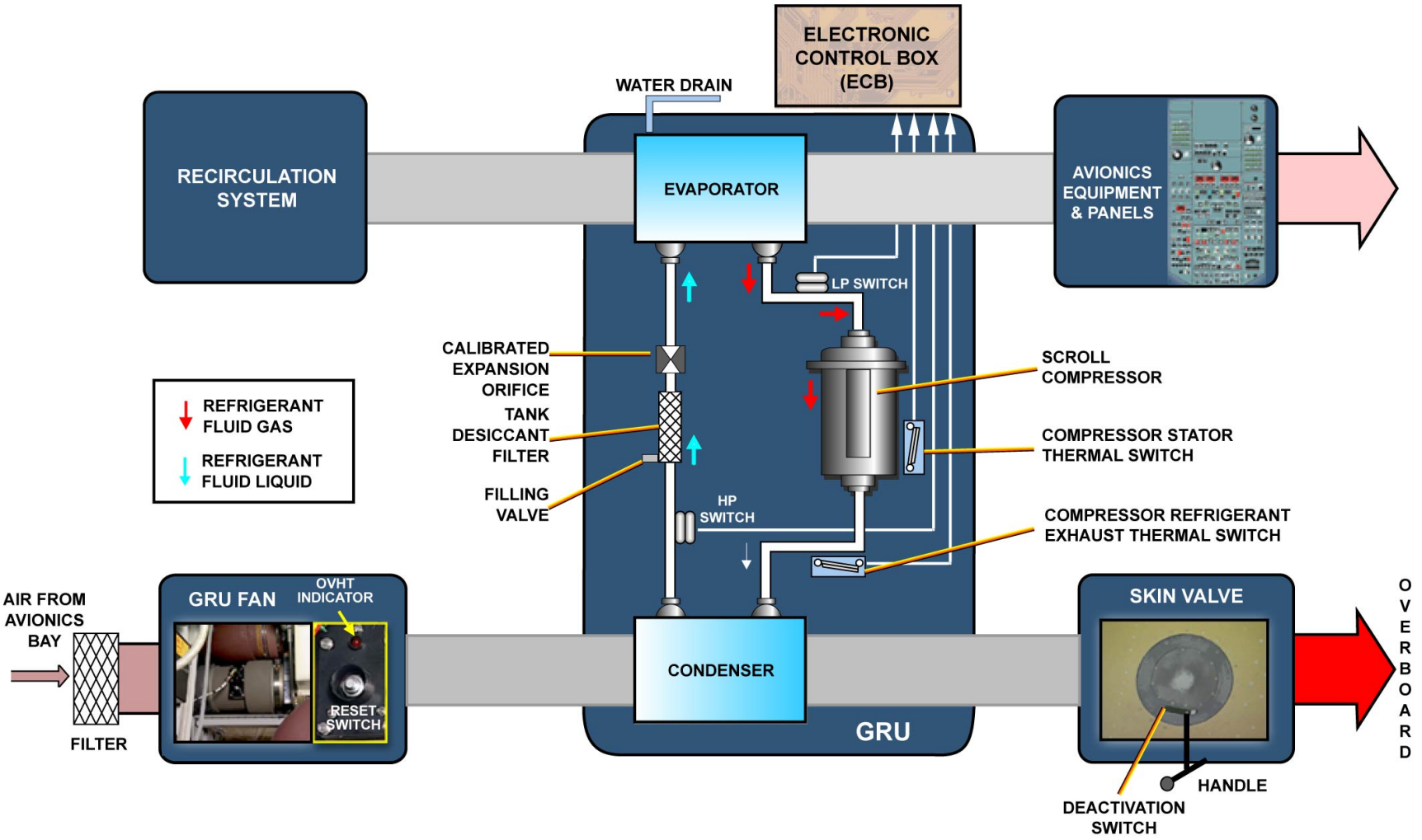
The fan is of the one speed design. It is directly controlled by the GRU Electronic Control Box (ECB). The fan starts and stops simultaneously with the GRU compressor.
A thermal switch is connected to the fan motor to stop the fan in case of overheat. There is an overheat indicator and a reset P/B installed on the fan housing.

GROUND REFRIGERATION UNIT (GRU)

The GRU is a compact assembly and consists of a refrigerant-fluid cycle system. When the refrigerant fluid is in a vapor state, it is compressed and transformed into liquid form by an electrical scroll compressor and cooled through a condenser.
The liquid passes through a tank desiccant filter to remove water particles and impurities. Then it is expanded through a calibrated expansion orifice in order to ensure sufficient sub-cooling.
The refrigerant fluid is piped to the evaporator where it is transformed into a gaseous state by cooling the air blown to the avionics. The condensation water formed in the evaporator is drained into the lower fuselage area.
The unit is controlled and monitored by an ECB located on the upper part of its structure. It is possible to test and reset the ECB through a specific connector. A plug protects this connector during GRU normal operation.
The GRU is equipped with a filling valve on the tank filter inlet. The valve is used for servicing the GRU. It is protected by a threaded plug.

SKIN VALVE

The GRU skin valve has two positions. The valve is actuated by a 28 VDC electrical motor. It is controlled and monitored by the Avionics Equipment Ventilation Controller (AEVC). In the event of an electrical failure, a manual override mechanism enables valve operation from outside the A/C. A deactivation switch set in the OFF position enables the valve to be manually operated by use of the stowed handle.



GENERAL PRINCIPLE & MAIN COMPONENTS

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AVIONICS EQUIPMENT GROUND COOLING D/O (OPTION) (3)

NORMAL OPERATION

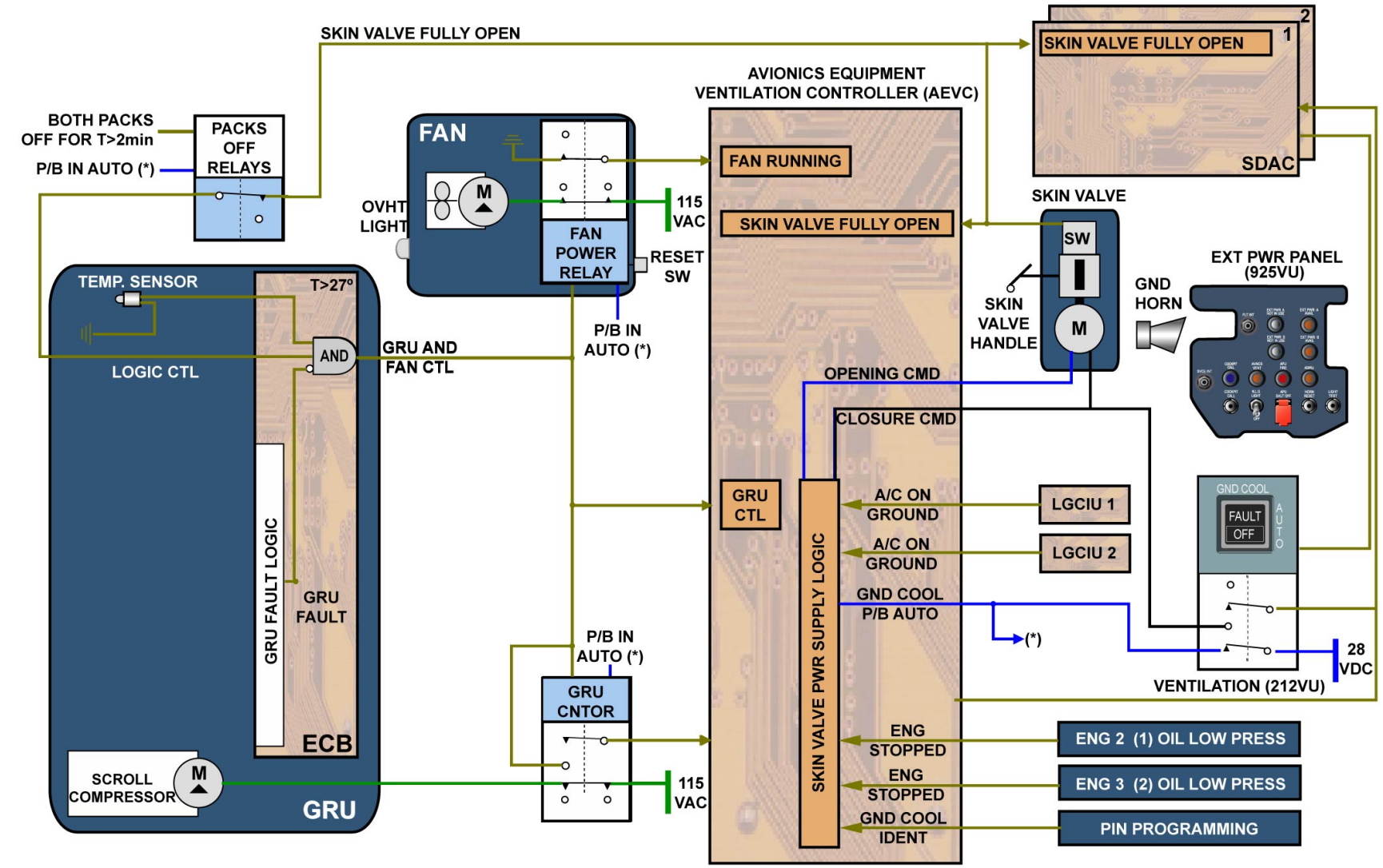
The system operation can be controlled through the GND COOL P/B.

AUTO CONTROL

When the GND COOL P/B is set to AUTO, the AEVC controls the skin valve to open, if the A/C is on ground, and the engines are shut down.
When the skin valve has reached its Fully Open (FO) position, and both air conditioning packs are stopped for at least 2 minutes, the valve open signal is sent to the GRU ECB.
As soon as the skin valve open signal is received, the GRU is in standby mode.
When the temperature exceeds 27.5ºC, the fan and the GRU are automatically powered. The automatic shutdown occurs when the temperature drops below 23ºC. The skin valve closure or at least one pack flow control valve opening lead to the fan and GRU shutdown.

MANUAL SHUTDOWN

When the GND COOL P/B is set to OFF, the skin valve is directly controlled to the closed position and the fan and GRU power supply is switched off through power relays control.



NORMAL OPERATION - AUTO CONTROL & MANUAL SHUTDOWN

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AVIONICS EQUIPMENT GROUND COOLING D/O (OPTION) (3)

ABNORMAL OPERATION

This topic will describe the abnormal operation of the avionics equipment GND cooling system.

VALVE JAMMING

If the skin valve is jammed in the open position at engine start, the crew must try to close the valve with the GND COOL P/B. If it fails to close, manual closure from the outside will be requested.
The skin valve jammed in the open position at engine start will cause the:
- illumination of the FAULT legend on the GND COOL P/B,
- generation of warnings on the EWD,
- display of amber skin valve indication on the CAB PRESS page,
- display of amber GND COOL indication on the CAB PRESS page.

If the skin valve is jammed in the closed position at engine shutdown, the GND COOL P/B must remain in AUTO position and manual opening from the outside is requested.
The skin valve jammed in the closed position at engine shutdown will cause the:
- illumination of the FAULT legend on the GND COOL P/B,
- generation of warnings on the EWD,
- display of amber skin valve indication on the CAB PRESS page,
- display of amber GND COOL indication on the CAB PRESS page,
- activation of the ground horn,
- illumination of the AVNCS VENT CAUT light on the external power panel.

VALVE DEACTIVATION/REACTIVATION

If manual operation is requested, a PUSH handle latch allows the handle to be folded out then deployed. Before turning the handle to close or open the valve, a deactivation switch must be set to the OFF position.
The deactivation switch must be set back to the ON position as soon as the problem is fixed in order to recover automatic control.

FAN OVERHEAT

If a fan overheat occurs, the overheat protection removes the power supply to the fan. The crew is requested to set the GND COOL P/B to the OFF position.
- A fan overheat will cause the:
- illumination of the OVHT light on the fan flange,
- illumination of the FAULT legend on the GND COOL P/B,
- generation of warnings on the EWD (VENT GND COOL FAULT),
- display of the amber GND COOL indication on the CAB PRESS page,
- activation of the ground horn,
- illumination of the AVNCS VENT CAUT light on the external warning panel.

FAN RESET

A fan reset must be performed after the OVHT light comes on and the trouble shooting procedure has been completed. The fan and the GRU will start and the OVHT light will go off, only if the overheat condition is no longer detected.

GRU FAILURE

If a fault occurs, a GRU fault logic in the ECB will automatically switch off the compressor motor and fan power supply. The GRU failure may also come from the GRU contactor malfunction.
A GRU failure will also cause the:
- illumination of the FAULT legend on the GND COOL P/B,
- generation of warnings on the EWD (VENT GND COOL FAULT),
- display of amber GND COOL indication on the CAB PRESS page,
- activation of the ground horn,
- illumination of the AVNCS VENT CAUT light on the external power panel,

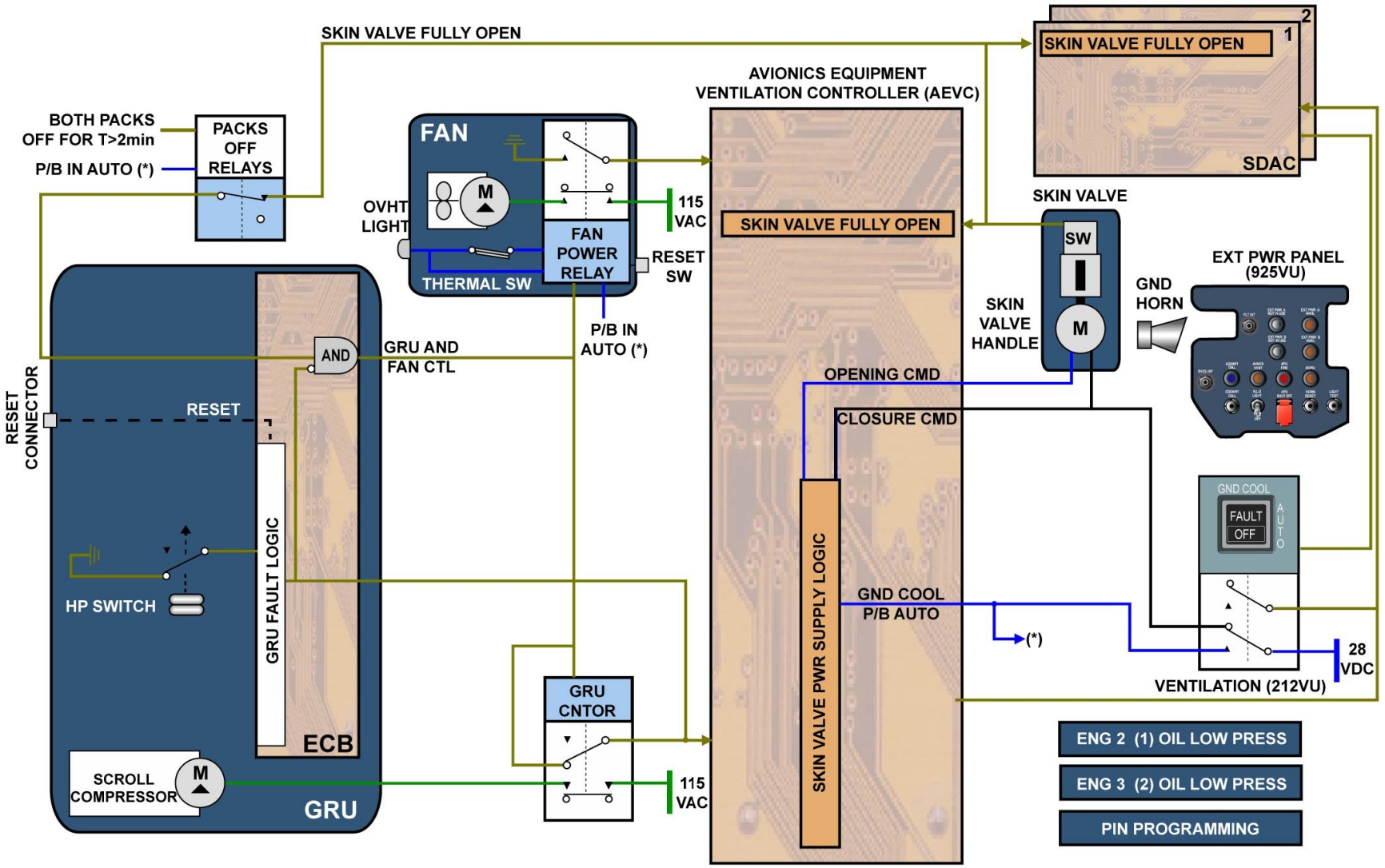
- the crew is requested to set the GND COOL P/B to the OFF position.

GRU RESET

If the reset of the GRU is performed from the overhead panel, the GRU may restart but the ECB memorizes the fault. It is only possible to clear the fault by means of a special fault control box connected to the GRU test and reset connector.

GRU TEST

If a failure occurs, it is possible to test the GRU by means of a special test control box connected to the GRU test and reset connector. However, it is impossible to start up the GRU again until the system failures that caused the overheating, overpressure or under pressure conditions have been corrected.



ABNORMAL OPERATION - VALVE JAMMING ... GRU TEST

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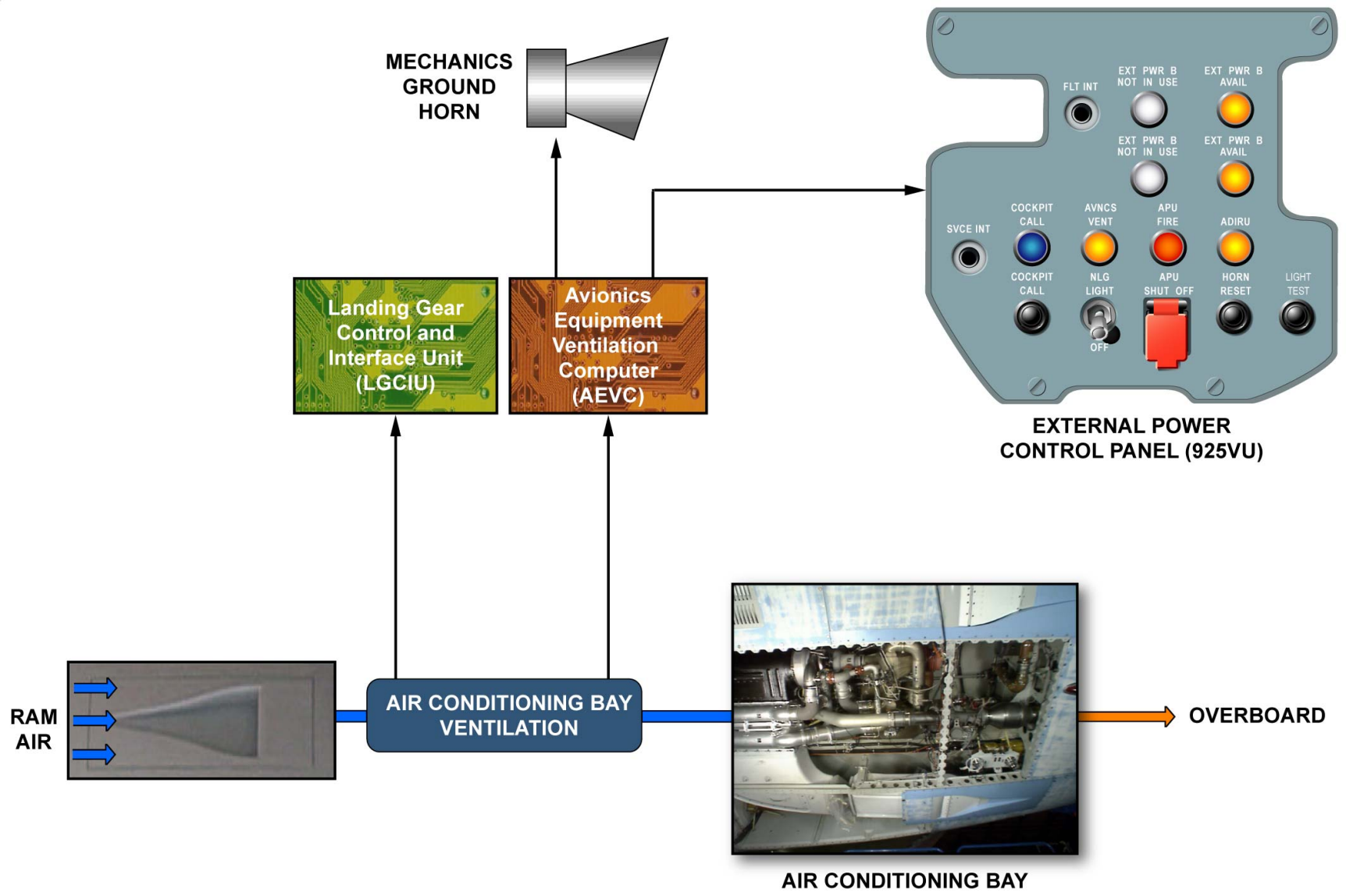
G9409341 - GAUT0T0 - FM21DDF21VL0202

SYSTEM D/O (3)

GENERAL

The system ensures proper air circulation in the air conditioning bay in order to maintain a temperature compatible with structure constraints in the relevant area.

G9409341 - GAUT0T0 - FM21DEAIRCBAY03



GENERAL

G9409341 - GAUT0T0 - FM21DEAIRCBAY03

SYSTEM D/O (3)

GENERAL (continued)

SYSTEM ARCHITECTURE

The left and right packs are located in the air conditioning bay. The air conditioning bay is located in the unpressurized belly fairing forward of the wheel well on the lower fuselage. The air conditioning packs and their associated hot air pipes provide in-operation heat dissipation. The air conditioning bay ventilation is performed through the left-hand pack and the right-hand pack. The ventilation principle is based on the use of external air through a NACA air inlet. Air is distributed by means of piccolo tubes and finally discharged overboard through an air outlet. The system has:
- a turbofan,
- a turbofan supply valve,
- a check valve,
- a pressure switch.

SYSTEM CONTROLS

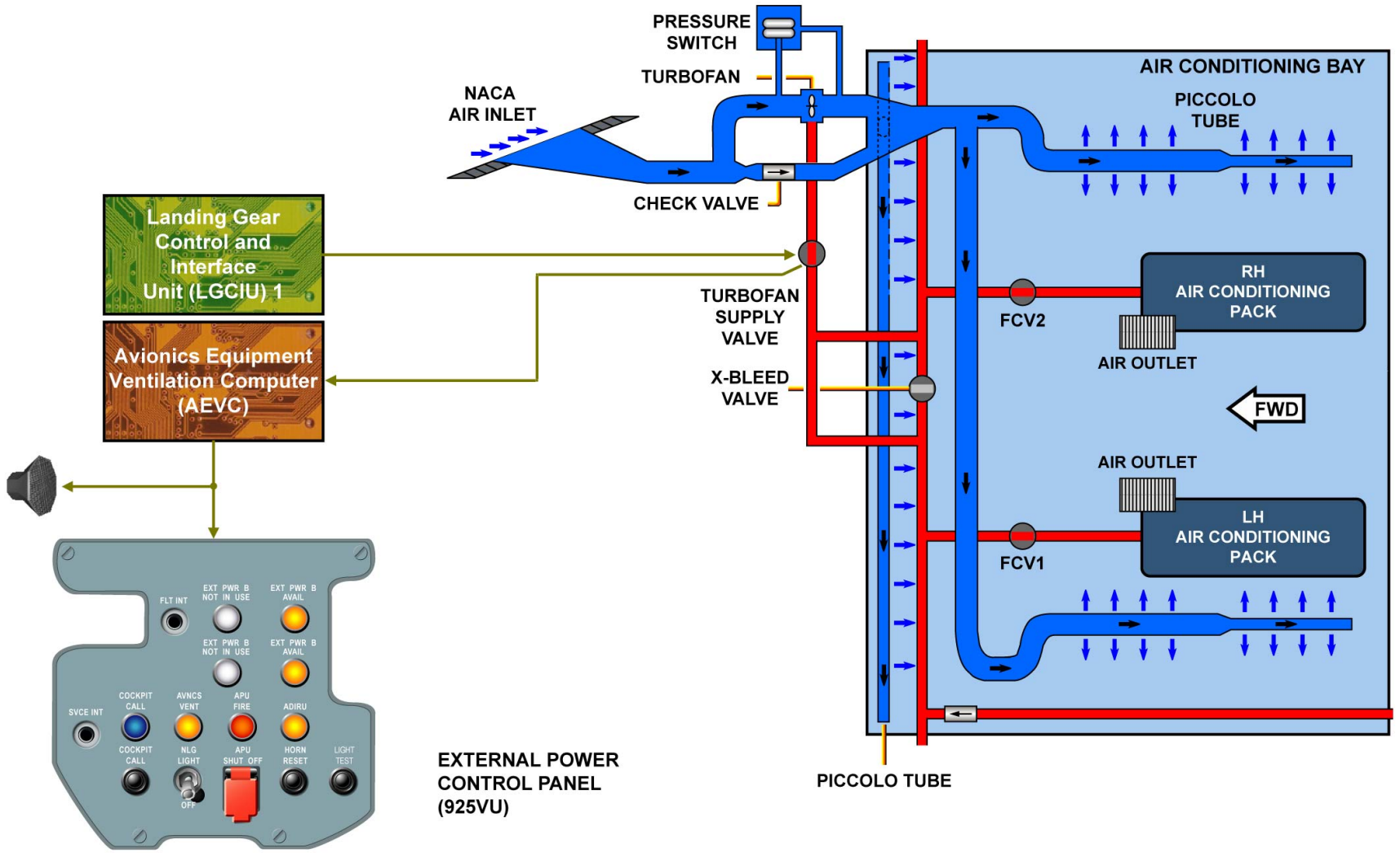
The turbo supply valve controls:
- start of the turbofan on ground,
- stop of the turbofan in flight.

The Landing Gear Control and Interface Unit (LGCIU) 1 directly controls turbofan supply valve.

SYSTEM MONITORING

The Avionics Equipment Ventilation Computer (AEVC) monitors the turbofan supply valve and the pressure switch to send the necessary information to the Central Maintenance Computer (CMC) to take the maintenance corrective action. In case of system abnormal operation, a visual warning is displayed on the external power control panel. In addition, an aural warning is triggered through the ground horn. In flight, a warning message on the EWD is displayed.

G9409341 - GAUT0T0 - FM21DEAIRCBAY03



GENERAL - SYSTEM ARCHITECTURE ... SYSTEM MONITORING

G9409341 - GAUT0T0 - FM21DEAIRCBAY03

SYSTEM D/O (3)

DESCRIPTION

The air conditioning packs are located in an unpressurized area on the lower fuselage. To ensure air circulation to maintain safe compartment temperatures, the air conditioning compartment ventilation system uses air supplied by a dedicated turbofan on ground and by a related NACA air inlet in flight. Three piccolo tubes enable correct air distribution in the air conditioning compartment. The ventilation air is discharged overboard through an orifice in the lower part of the belly fairing.

AEVC

The AEVC monitors the position of turbofan supply valve. It also monitors the pressure switches for sufficient airflow to the compartment. The AEVC outputs are:
- one discrete output connected to both System Data Acquisition Concentrators (SDAC) in order to generate class 2 fault signals,
- one ARINC 429 bus connected to the CMC to generate the relevant maintenance messages.

TURBOFAN

The turbofan is located in the belly fairing and is attached to the A/C structure by four shock absorbers. The turbofan is a pneumatic-powered, turbine-driven fan. Its housing can contain fan impeller fragments in case of a failure.

TURBOFAN SUPPLY VALVE

The pneumatically operated turbofan supply valve is installed on the turbofan turbine air supply line. A solenoid controls the valve open and closed and it is spring-loaded closed in the absence of air pressure. A safety altitude device prevents inadvertent opening of the valve when the A/C altitude exceeds 15,000 ft. Two microswitches are fitted to supply position information.

CHECK VALVE

A check valve is installed on the ventilation system of the air conditioning compartment. It is closed on ground and open in flight. The check valve prevents air recirculation in the duct and ensures correct operation of the turbofan.

PRESSURE SWITCH

The differential pressure switch is monitored by the AEVC. The pressure switch position is used with the pack Flow Control Valve (FCV) position to trigger a warning when the FCV is open and the pressure switch is sensing low flow.

OPERATION

The air conditioning bay ventilation system has 2 operational modes:
- a ground mode,
- a flight mode.

ON GROUND

On the ground, the LGCIU 1 controls the turbofan supply valve to open, by de-energizing the valve solenoid. Provided there is pneumatic supply (crossbleed duct supplied), high-pressure air passes through the turbofan supply valve and drives the turbofan. Then, the turbofan draws air, through the NACA air inlet, to supply the necessary airflow in the air conditioning compartment. The check valve is closed during operation. The turbine airflow is discharged into and mixed with the turbofan air. A pressure switch is connected to the upstream turbofan pressure-port (port P2) and to the downstream turbofan pressure-port (port P1). This permits ventilation monitoring of the air conditioning compartment provided at least one FCV is open.

IN FLIGHT

In flight, ram air through the NACA inlet is sufficient for cooling, so the LGCIU1 controls the turbofan supply valve closed by energizing the solenoid.

ABNORMAL OPERATION

Here is a detailed description of the different failures that can occur in the air conditioning bay ventilation system.

MAINTENANCE ACTION

For maintenance action on ground, a blanking plug is fitted in the vicinity of the turbofan to blank the turbine supply line. This deactivates a failed turbofan and allows dispatch under Master Minimum Equipment List (MMEL) condition. The blanking plug prevents:
- permanent hot air leakage on the ground in case of failure of the turbofan (jammed),
- excessive rotation speed of the turbofan in flight in case of failure of the turbofan supply valve (jammed in the open position).

TURBOFAN SUPPLY VALVE FAILURE

On ground, if the turbofan supply valve fails to open when one pack FCV is open, the following warnings are activated:
- a warning message is displayed on the EWD,
- an audio warning is triggered through the ground horn,
- an AVioNiCS VENTilation caution light comes on the external power control panel,
- a message is sent to the Central Maintenance System (CMS). The packs should be switched OFF on the ground. They can be selected back ON after takeoff.

In flight, if the supply valve is detected open by the AEVC, the warnings are activated:
- a warning message is displayed on the EWD,
- a message is sent to the CMS.

TURBOFAN JAMMING

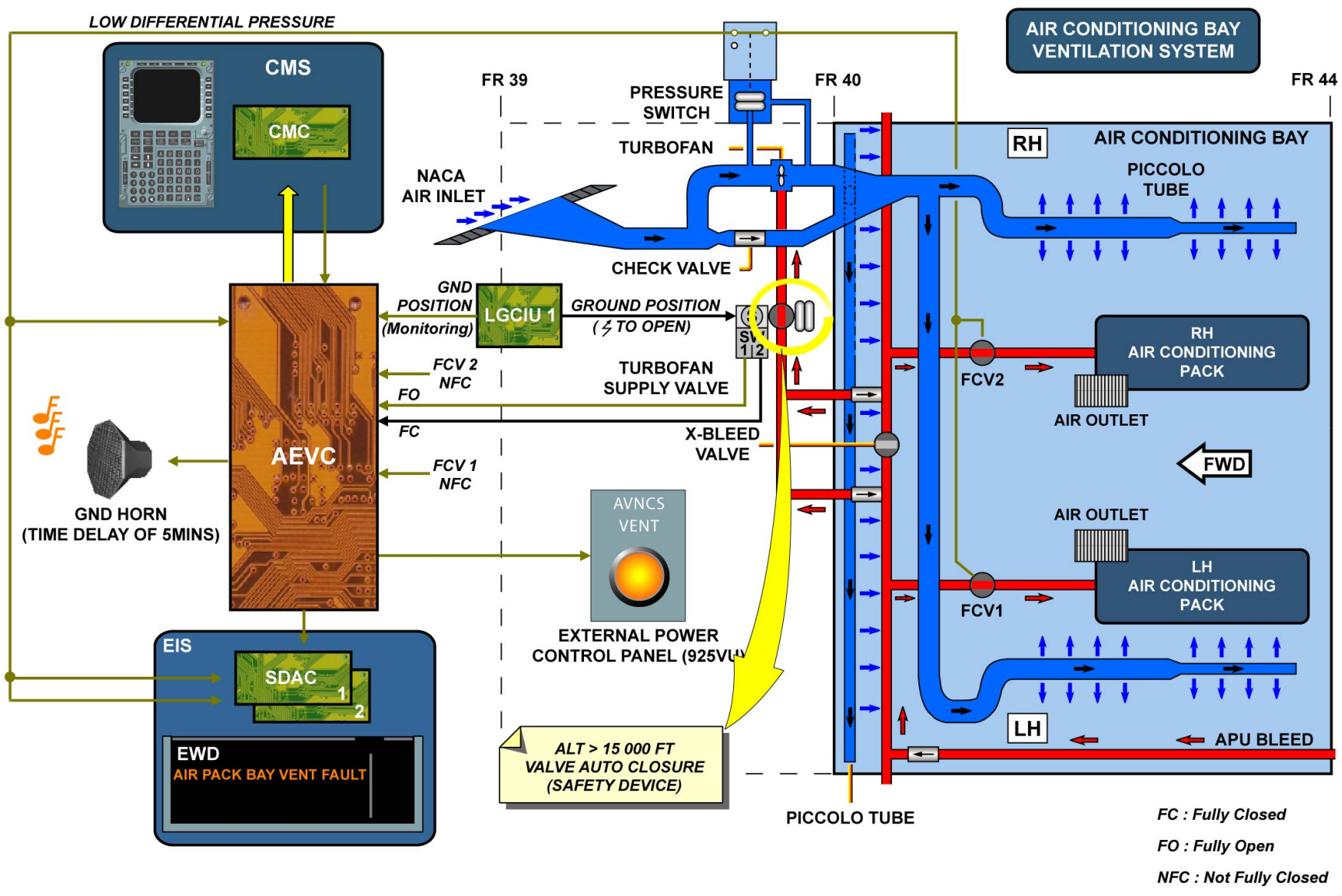
On ground, if the turbofan is detected jammed by the pressure switch, when at least one FCV is open, these warnings are activated:
- a warning message is displayed on the EWD,
- an audio warning is triggered through the ground horn,
- an AVNCS VENT caution light appears on the external power control panel,
- a message is sent to the CMS.

The packs should be switched OFF on the ground. They can be selected back ON after takeoff. A maintenance action with the blanking plug is needed before dispatch under MMEL condition.

CHECK VALVE FAILURE

A check valve stuck in the closed position cannot be detected. But on ground, the pressure switch enables a check valve stuck in open position to be detected and the warnings to be activated:
- a warning message is displayed on the EWD,
- an audio warning is triggered through the ground horn,
- an AVNCS VENT caution light appears on the external power control panel,
- a message is sent to the CMS.

The packs should be switched OFF on the ground. They can be selected back ON after takeoff.



DESCRIPTION ... ABNORMAL OPERATION

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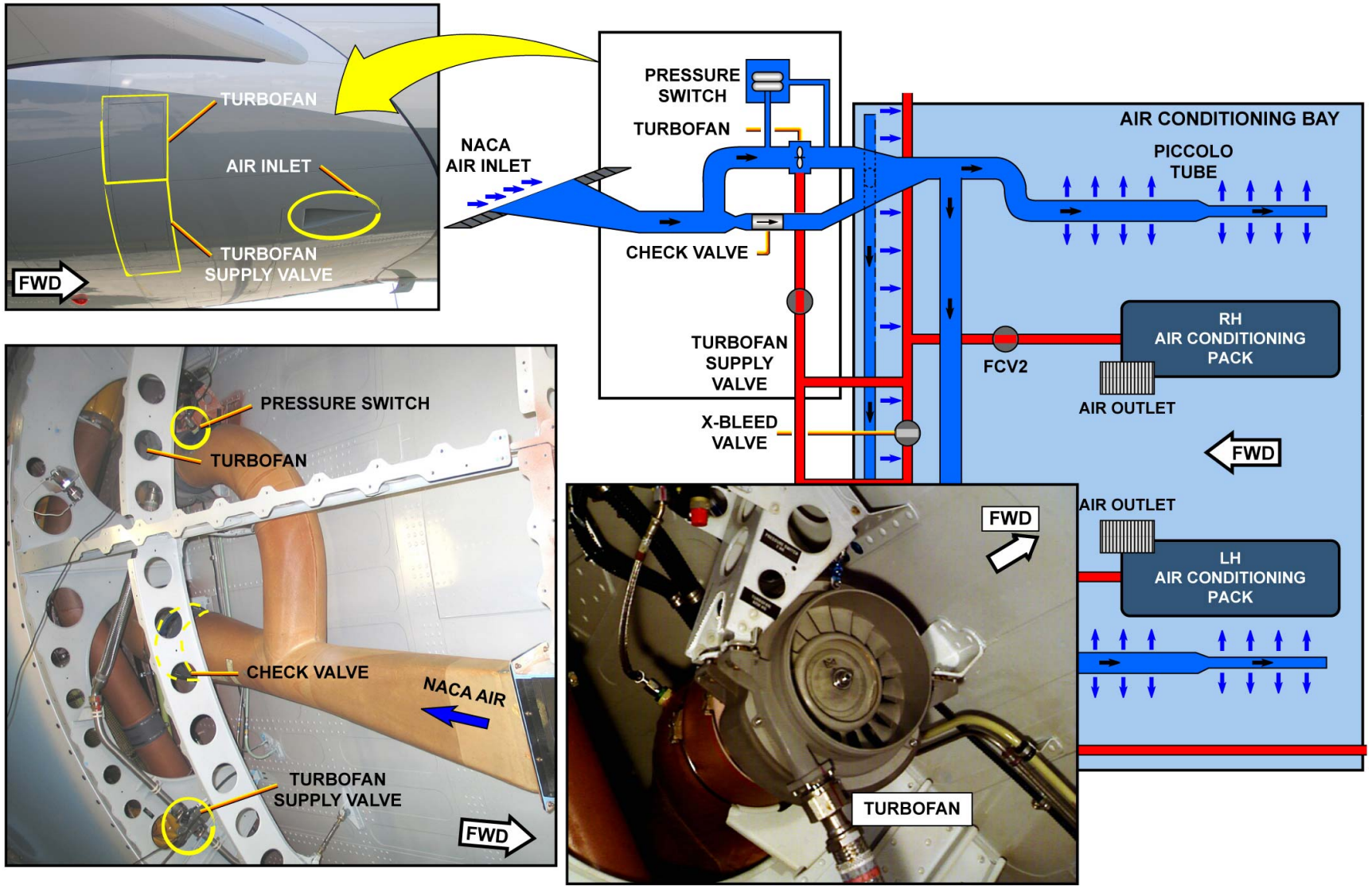


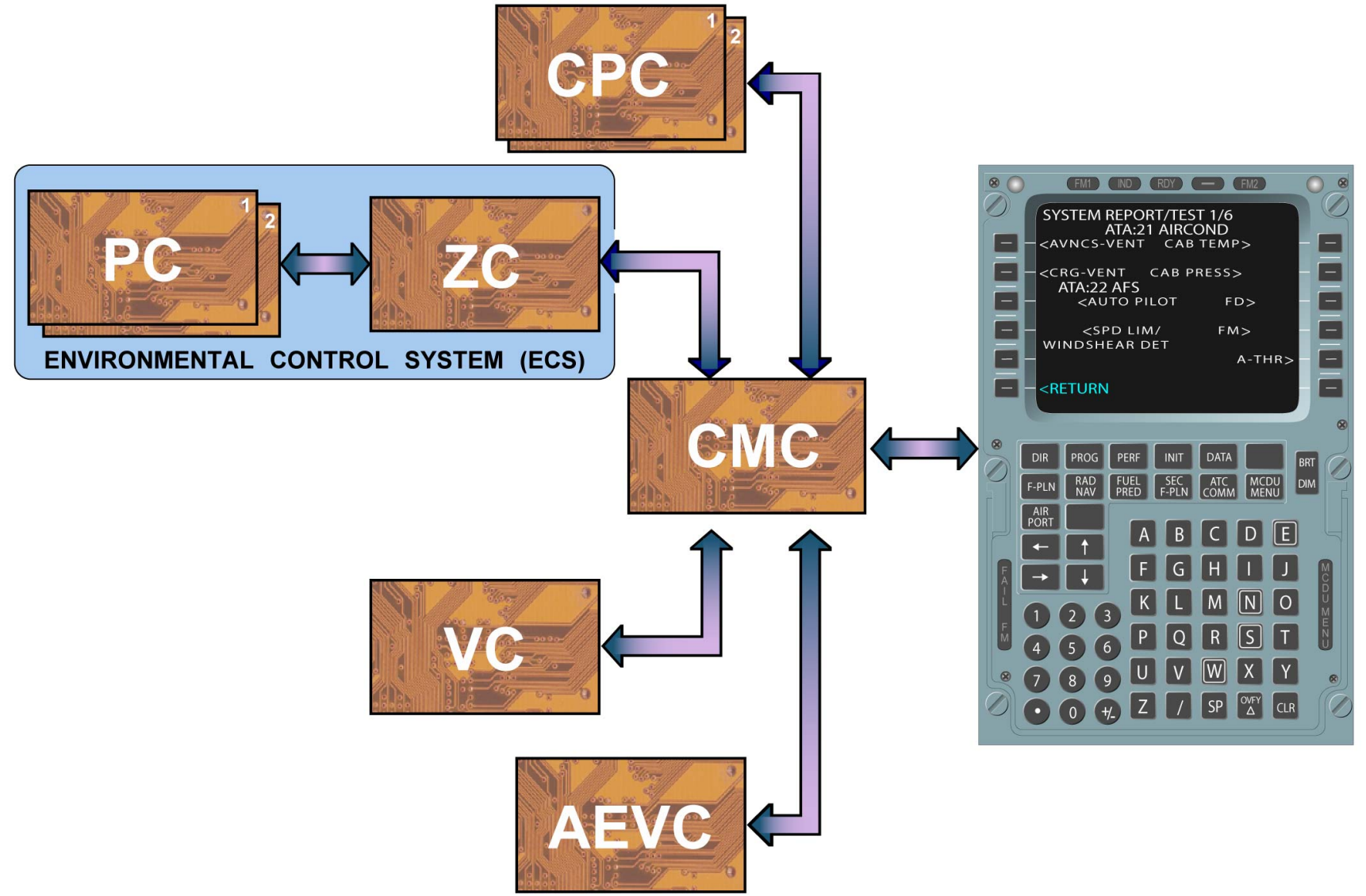
DESCRIPTION ... ABNORMAL OPERATION

G9409341 - GAUT0T0 - FM21DEAIRCBAY03

AIR CONDITIONING MCDU PAGES (2)

GENERAL

The SYSTEM REPORT/TEST function of the CMS ground menu, on the MCDU for the air conditioning system, gives access to an interactive mode.
This mode allows fault interrogation and testing of:
- the Avionics Equipment and Ventilation Controller (AEVC),
- the Ventilation Controller (VC),
- the Environmental Control System (ECS) through the Zone Controller (ZC) and the Pack Controllers (PCs),
- and finally the Cabin Pressure Controllers (CPCs).



GENERAL

G9409341 - GAUT0T0 - FM21P7MCDUTST02

AIR CONDITIONING MCDU PAGES (2)

AIR CONDITIONING TEST CAPABILITY

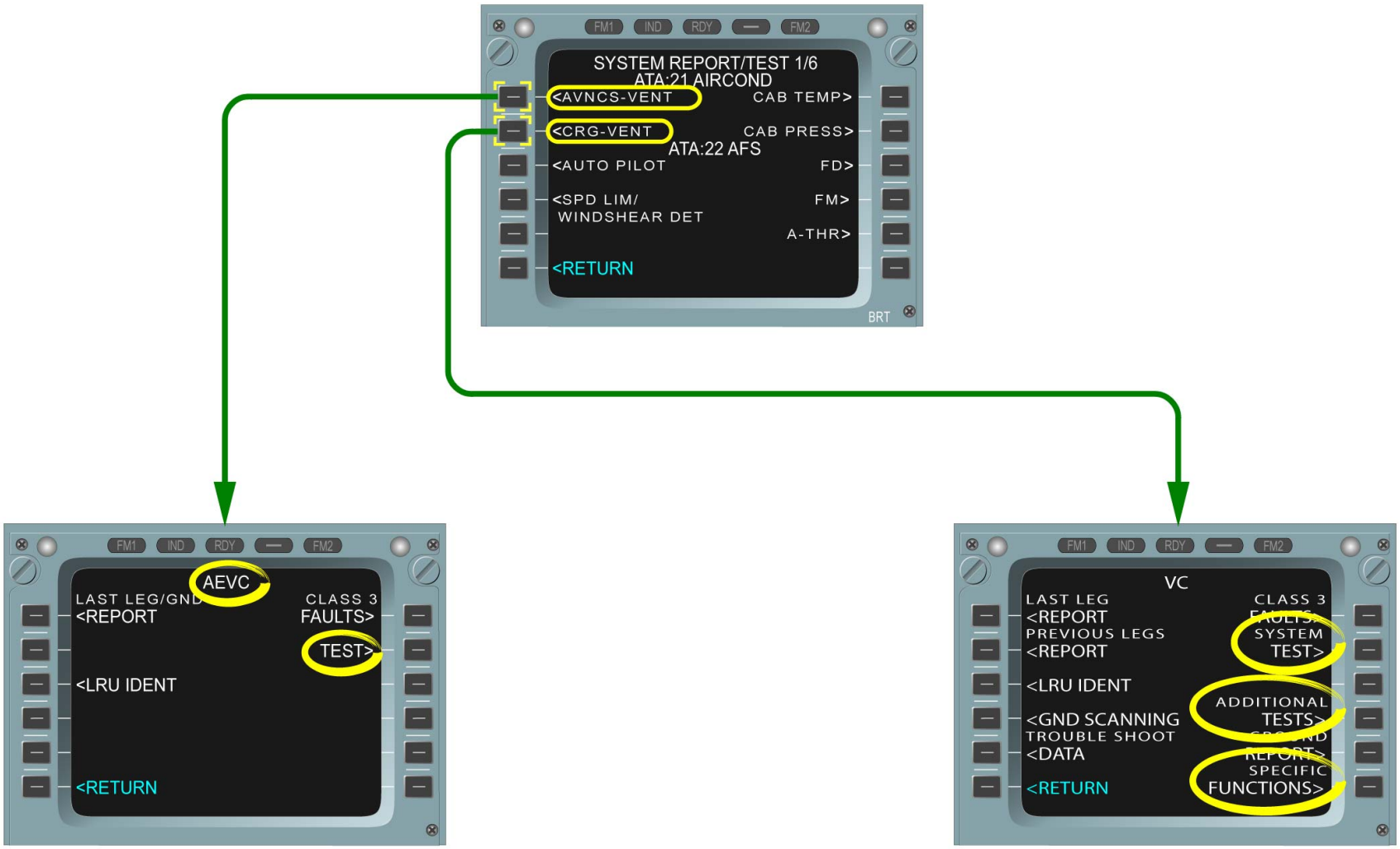
The air conditioning SYSTEM REPORT TEST capabilities are:
- the AVNCS VENT test,
- the CRG VENT tests and the specific functions,
- the CAB TEMP tests and the specific data,
- and the CAB PRESS test.

AVNCS VENT TEST

From the main menu of the air conditioning SYSTEM REPORT TEST, the selection of the AVNCS-VENT line key will give access to the Avionics Equipment and Ventilation Controller (AEVC)menu.
The AEVC is a type 2 computer which allows the operator to perform a system test including an overboard extract valve functional cycle test.

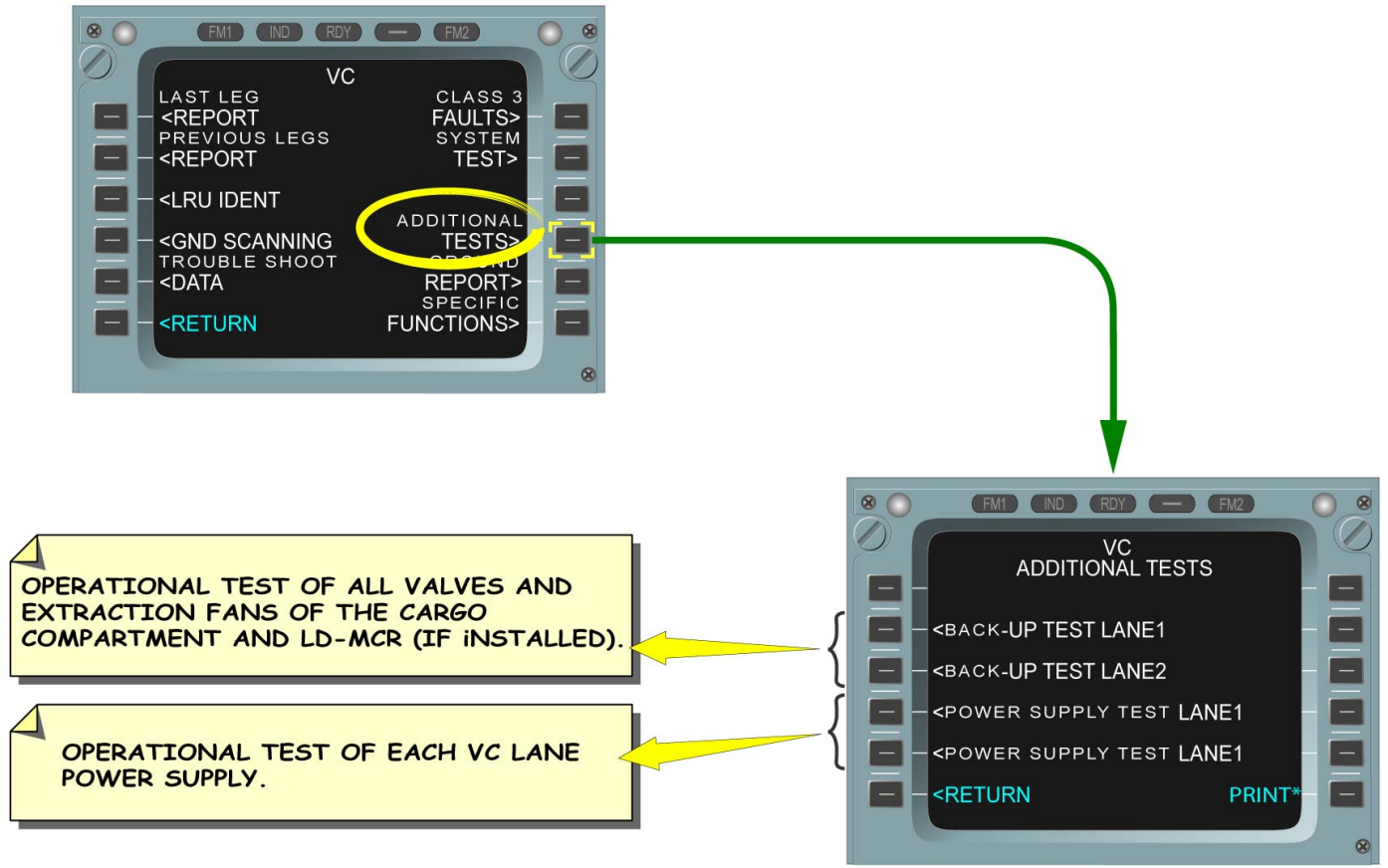
CRG VENT TESTS AND SPECIFIC FUNCTIONS

From the main menu of the air conditioning SYSTEM REPORT TEST, the selection of the CRG-VENT line key will give access to the Ventilation Controller (VC) menu.
The VC is a type 1 computer with GND SCANNING capability. In addition, the VC menu page allows the operator to perform the following specific functions:
- the SYSTEM TEST to check the VC and the related components,
- the ADDITIONAL TEST which are the back up test and the power supply test,
- the SPECIFIC FUNCTIONS to display specific data and component status.



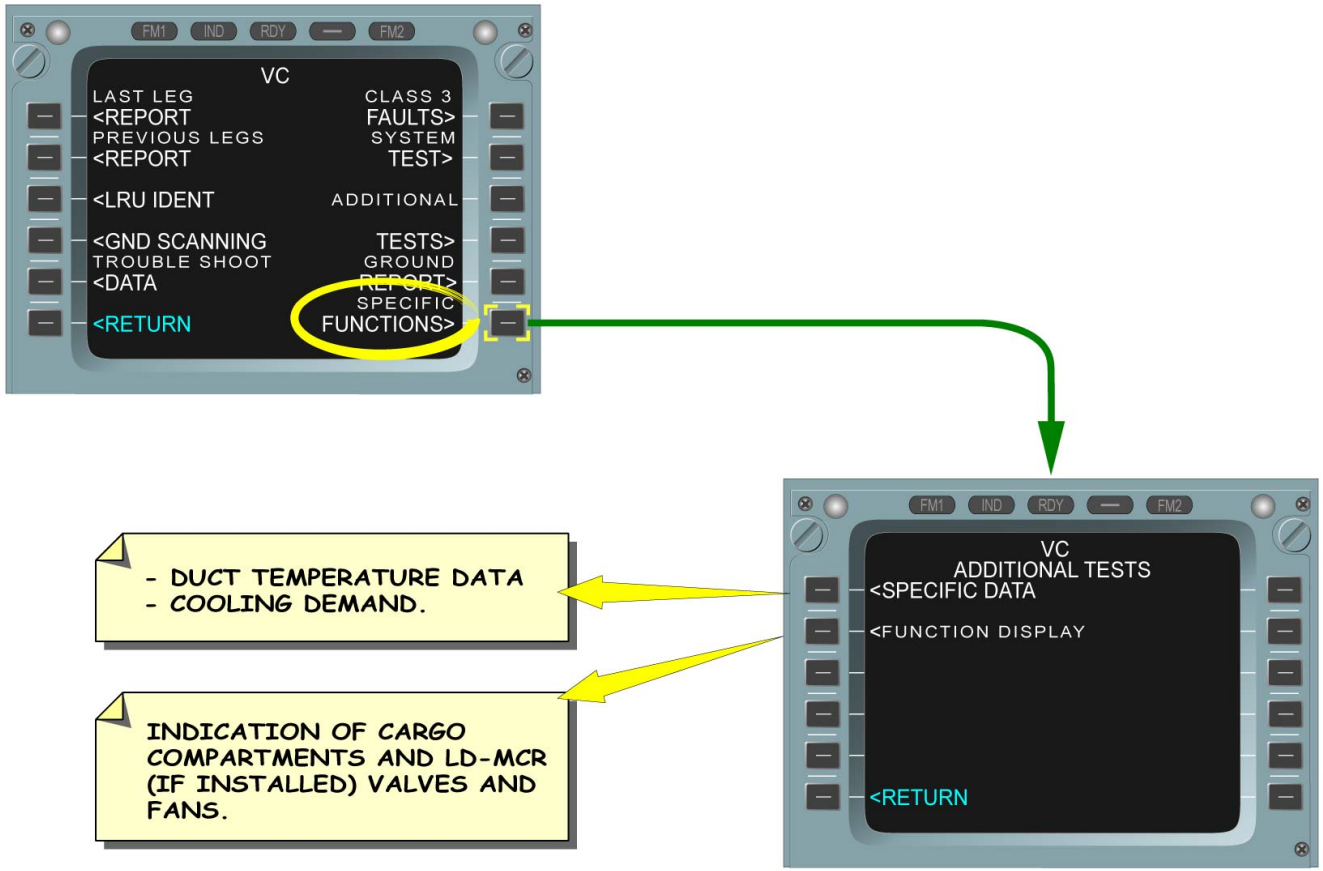
AIR CONDITIONING TEST CAPABILITY - AVNCS VENT TEST & CRG VENT TESTS AND SPECIFIC FUNCTIONS

G9409341 - GAUT0T0 - FM21P7MCDUTST02



AIR CONDITIONING TEST CAPABILITY - AVNCS VENT TEST & CRG VENT TESTS AND SPECIFIC FUNCTIONS

G9409341 - GAUT0T0 - FM21P7MCDUTST02



AIR CONDITIONING TEST CAPABILITY - AVNCS VENT TEST & CRG VENT TESTS AND SPECIFIC FUNCTIONS

G9409341 - GAUT0T0 - FM21P7MCDUTST02

AIR CONDITIONING MCDU PAGES (2)

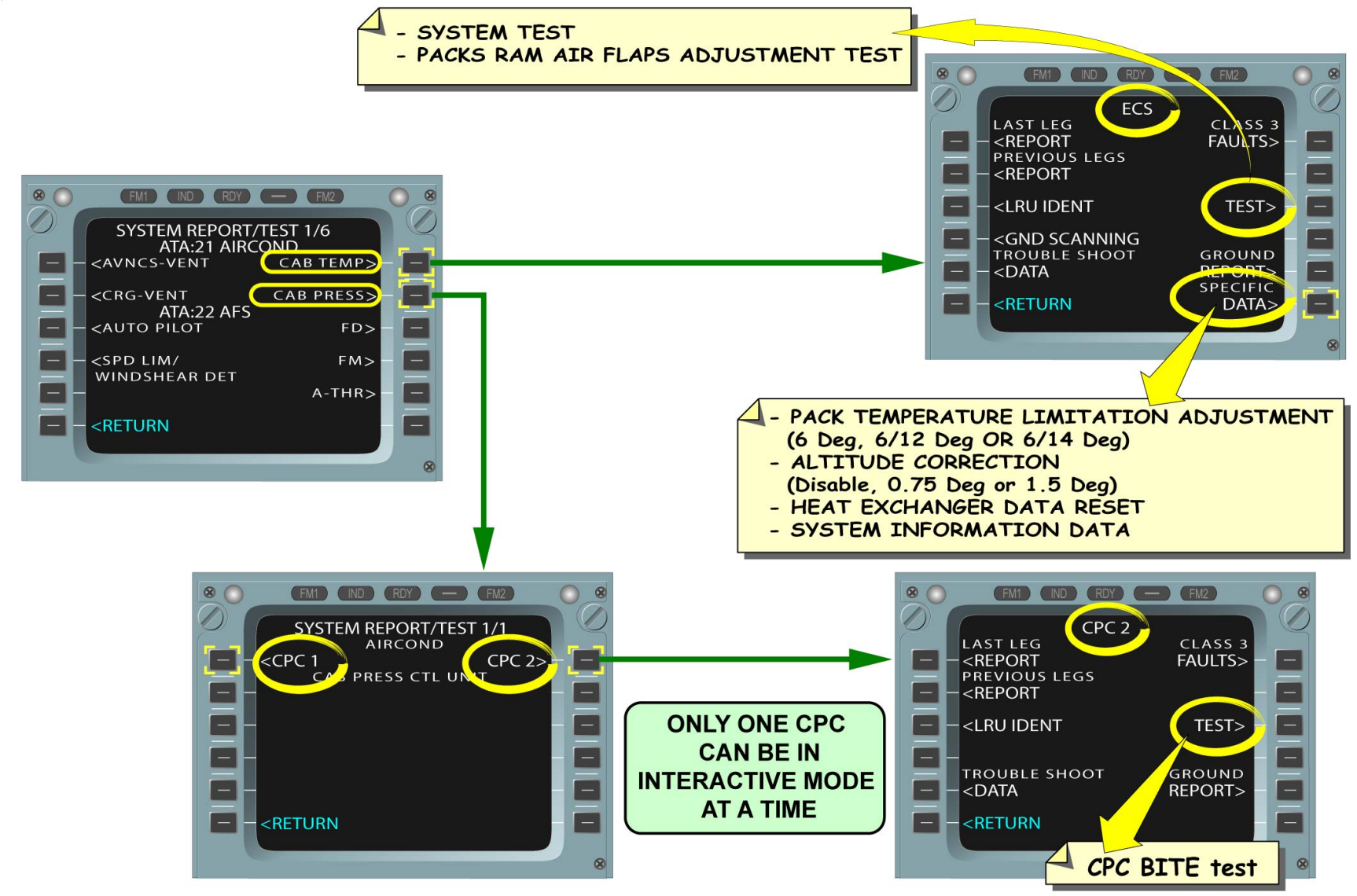
AIR CONDITIONING TEST CAPABILITY (continued)

CAB TEMP TESTS AND SPECIFIC DATA

From the main menu of the air conditioning SYSTEM REPORT TEST, the selection of the CAB TEMP line key will give access to the Environmental Control System (ECS) menu.
The ECS menu enables interrogation of the Zone Controller (ZC) and the Pack Controllers (PCs) which are type 1 computers with GND SCANNING capability. In addition, the ECS system page allows the operator to perform the following specific functions:
- the TEST to check the ZC, the PCs and their related components, as well as the pack flap rigging purposes,
- the SPECIFIC DATA to display system data and to adjust temperature parameters as duct temperature limitation and altitude correction.

CAB PRESS TEST

From the main menu of the air conditioning SYSTEM REPORT TEST, the selection of the CAB PRESS line key will give access to the Cabin Pressure Controllers (CPCs) menu.
Tests can be performed through CPC 1 or CPC2.
The CPCs are type 1 computers with GND SCANNING capability.
The CPCs menu allows the operator to perform the TEST of the computers and their related components.



AIR CONDITIONING TEST CAPABILITY - CAB TEMP TESTS AND SPECIFIC DATA & CAB PRESS TEST

G9409341 - GAUT0T0 - FM21P7MCDUTST02

AIR CONDITIONING SYSTEM BASE MAINTENANCE (3)

FILTER ELEMENTS REMOVAL AND INSTALLATION

The purpose of this module is to present the FWD and AFT recirculation filter elements removal and installation.

NOTE: Note that the aft filter elements are disposable and not cleanable.

JOB SET-UP

WARNING: MAKE SURE THAT AIR IS NOT SUPPLIED TO THE AIR CONDITIONING SYSTEM FROM THE MAIN ENGINE, THE APU OR A GROUND SOURCE. HOT COMPRESSED AIR CAN CAUSE INJURY TO STAFF.

Open the FWD cargo compartment door for FWD filters access and the AFT cargo compartment door for AFT filters access.
Remove applicable panels to get access to filters. For the FWD filters, remove the FWD cargo compartment rear wall panels. For the AFT filters, remove the FWD wall panels.
On the AIR control panel, make sure that the APU BLEED, the ENG BLEED and the PACK 1(2) P/BSWs are released out (OFF legend on). Put a warning notice on the High Pressure (HP) and Low Pressure (LP) ground connectors to warn persons not to supply the A/C with a ground air source.

G9409341 - GAUT0T0 - FM21Y2BASEMCE03

Filter elements removal/installation

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Job set-up

...

- **Aircraft maintenance configuration**
- **Safety precautions**

...

Procedure

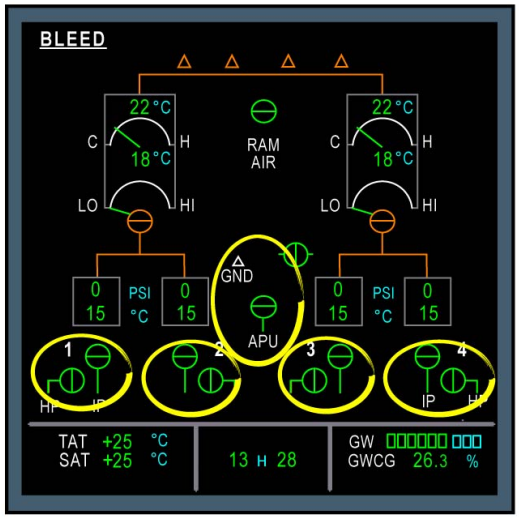
...

- **Removal of the forward filter elements**
- **Removal of the aft filter elements**
- **Installation of the forward filter elements**
- **Installation of the aft filter elements**

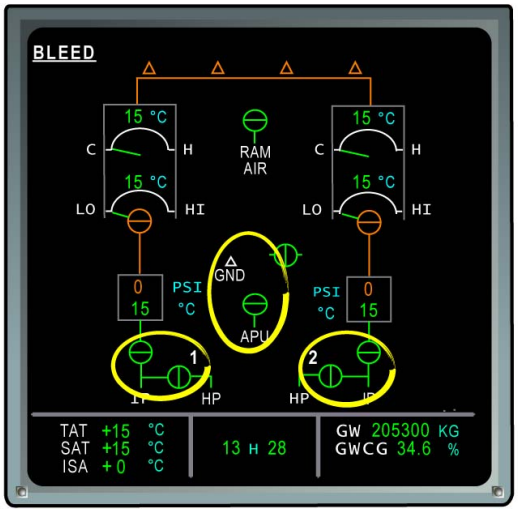
...

Close-up

...



A340 ECAM BLEED PAGE



A330 ECAM BLEED PAGE

FILTER ELEMENTS REMOVAL AND INSTALLATION - JOB SET-UP

Filter elements removal/installation

...

Job set-up

...

Aircraft maintenance configuration

Safety precautions

...

Procedure

...

Removal of the forward filter elements

Removal of the aft filter elements

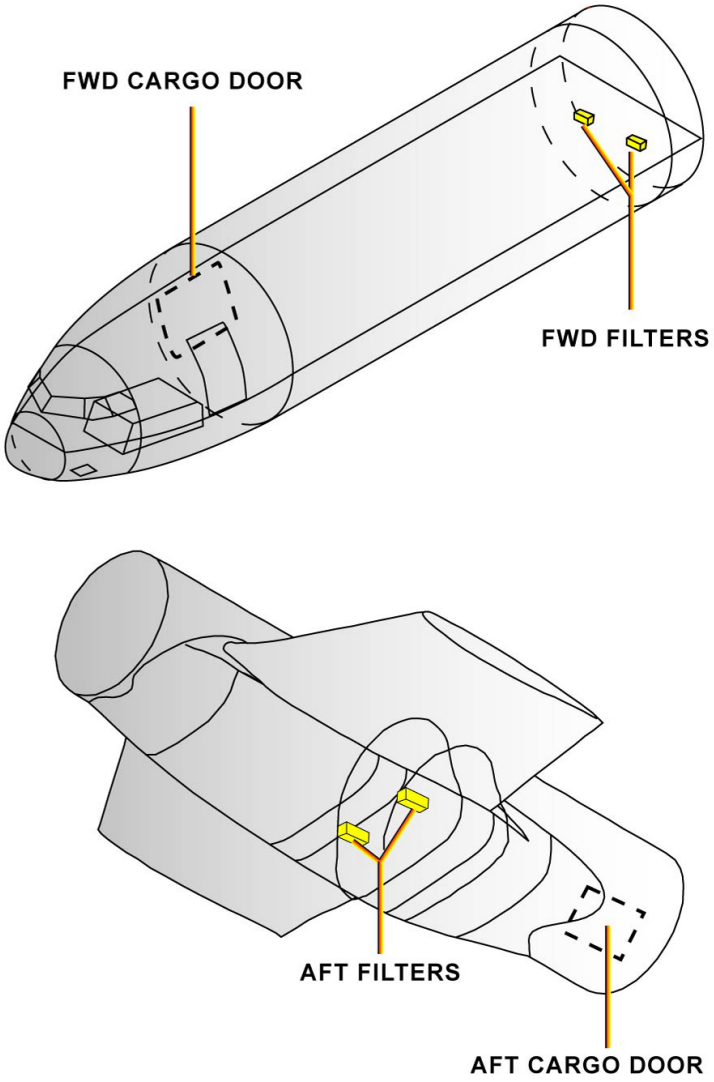
Installation of the forward filter elements

Installation of the aft filter elements

...

Close-up

...



FILTER ELEMENTS REMOVAL AND INSTALLATION - JOB SET-UP

Filter elements removal/installation

...

Job set-up

...

✓ Aircraft maintenance configuration

⇨ Safety precautions

...

Procedure

...

Removal of the forward filter elements

Removal of the aft filter elements

Installation of the forward filter elements

Installation of the aft filter elements

...

Close-up

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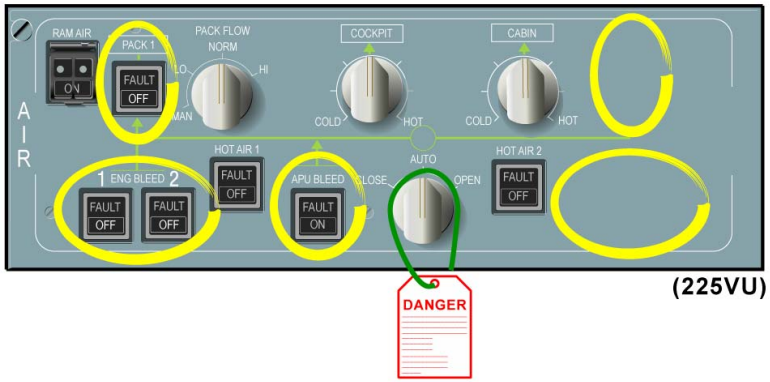
A340 AIR PANEL



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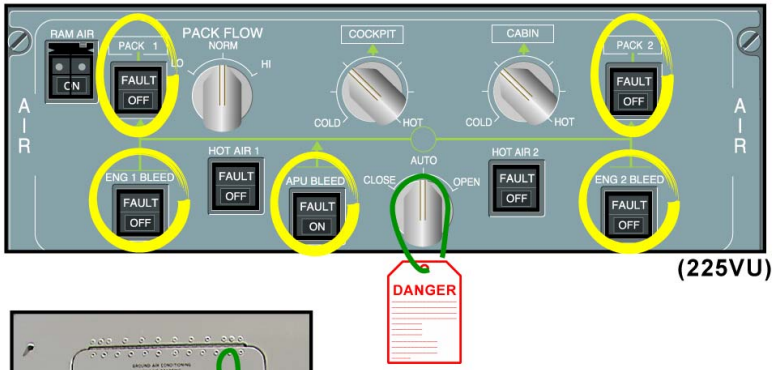
A330 AIR PANEL



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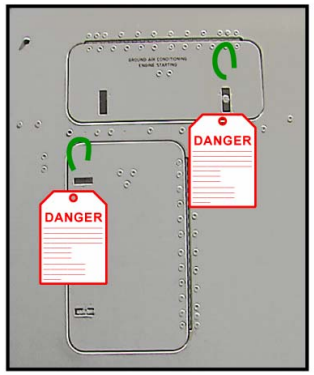

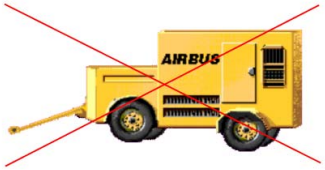

FILTER ELEMENTS REMOVAL AND INSTALLATION - JOB SET-UP

G9409341 - GAUT0T0 - FM21Y2BASEMCE03

AIR CONDITIONING SYSTEM BASE MAINTENANCE (3)

FILTER ELEMENTS REMOVAL AND INSTALLATION (continued)

REMOVAL OF THE FWD FILTER ELEMENTS

CAUTION: Do not step on the ducts due to their fragility. You must replace all the filters on the same side of the A/C at the same time:
-the RH FWD filters with the RH AFT filters,
-the LH FWD filters with the LH AFT filters.

To remove the left FWD filter elements:
- unlock the locks and open the fasteners of the mounting assembly,
- release each of the two fasteners,
- pull the tabs off the studs,
- disengage the channels from the two studs and pull the filter element,
- remove the filter element from its mounting assembly.

Use the same procedure to remove the right FWD filter elements.

G9409341 - GAUT0T0 - FM21Y2BASEMCE03

Filter elements removal/installation

...

✓ **Job set-up**

...

✓ **Aircraft maintenance configuration**

✓ **Safety precautions**

...

Procedure

...

⇨ **Removal of the forward filter elements**

Unlock the locks and open the fasteners of the mounting assembly.
Release each of the two fasteners.
Pull the tabs off the studs.
Disengage the channels from the two studs and pull the filter element.
Remove the filter element from its mounting assembly.
...

Removal of the aft filter elements

Installation of the forward filter elements

Installation of the aft filter elements

...

Close-up

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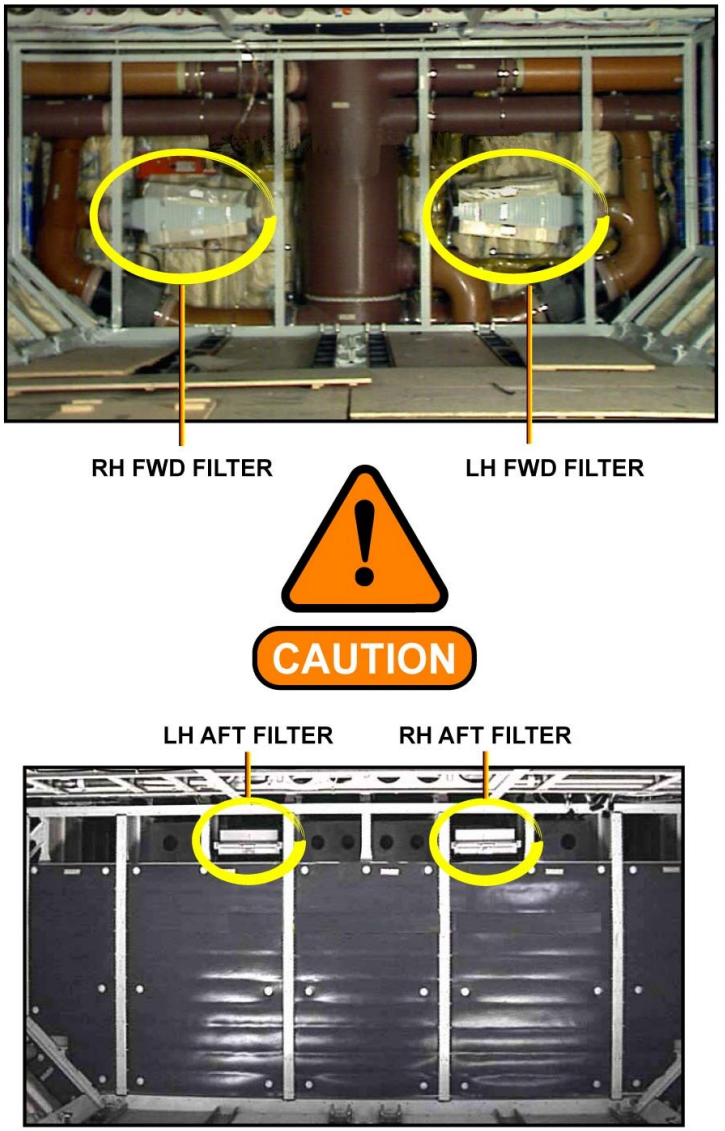


FILTER ELEMENTS REMOVAL AND INSTALLATION - REMOVAL OF THE FWD FILTER ELEMENTS

G9409341 - GAUT0T0 - FM21Y2BASEMCE03

Filter elements removal/installation

...

Job set-up

...

Aircraft maintenance configuration

Safety precautions

...

Procedure

...

Removal of the forward filter elements

Unlock the locks and open the fasteners of the mounting assembly.
Release each of the two fasteners.
Pull the tabs off the studs.
Disengage the channels from the two studs and pull the filter element.
Remove the filter element from its mounting assembly.

...

Removal of the aft filter elements

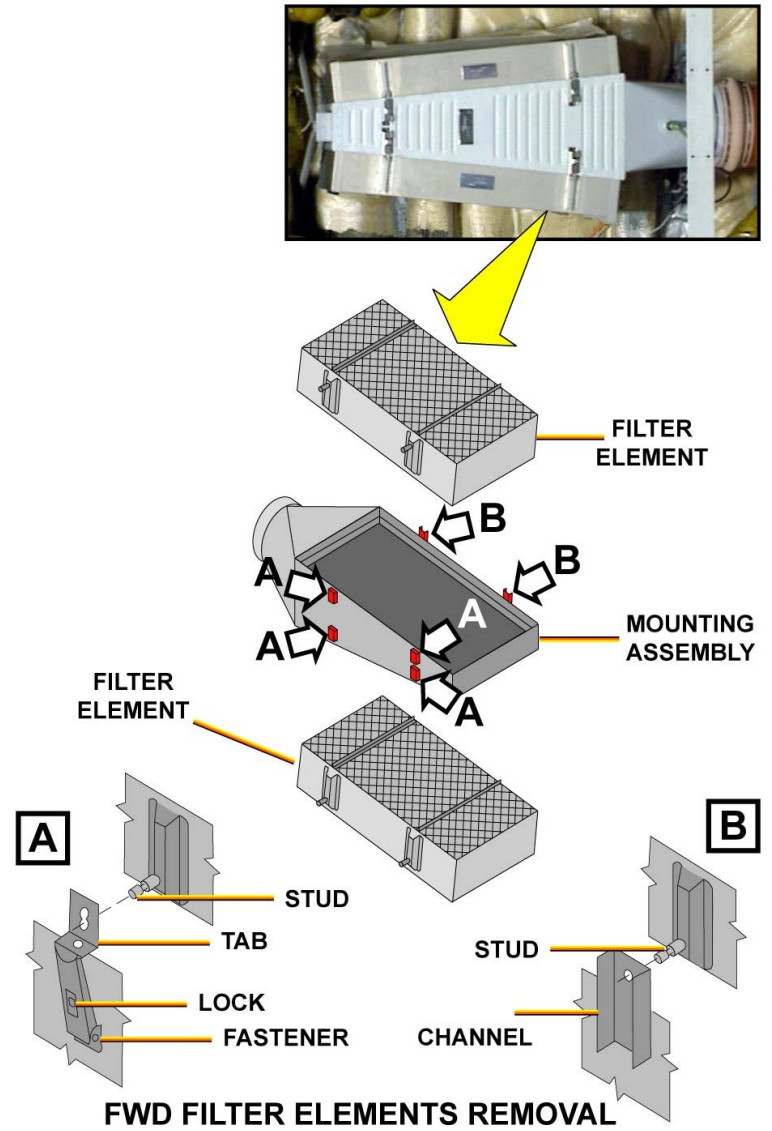
Installation of the forward filter elements

Installation of the aft filter elements

...

Close-up

...



FILTER ELEMENTS REMOVAL AND INSTALLATION - REMOVAL OF THE FWD FILTER ELEMENTS

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AIR CONDITIONING SYSTEM BASE MAINTENANCE (3)

FILTER ELEMENTS REMOVAL AND INSTALLATION (continued)

REMOVAL OF THE AFT FILTER ELEMENTS

The AFT filter elements removal procedure is similar to the one for the FWD filter elements. The AFT filters are accessible through the forward wall of the aft cargo compartment.

Filter elements removal/installation

...

✓ Job set-up

...

✓ Aircraft maintenance configuration

✓ Safety precautions

...

Procedure

...

✓ Removal of the forward filter elements

⇨ Removal of the aft filter elements

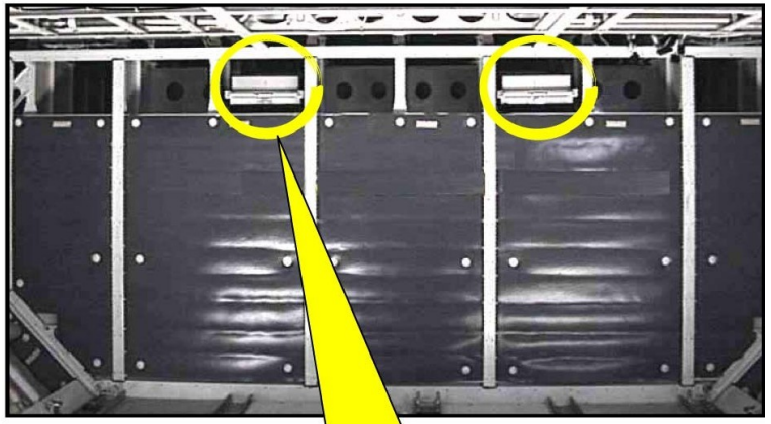
Installation of the forward filter elements

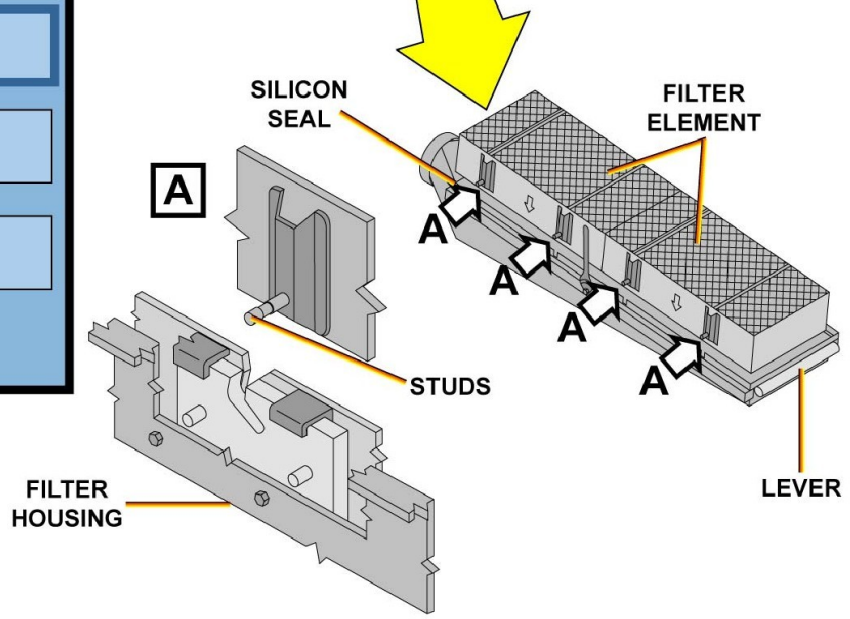
Installation of the aft filter elements

...

Close-up

...





AFT FILTER ELEMENTS REMOVAL

FILTER ELEMENTS REMOVAL AND INSTALLATION - REMOVAL OF THE AFT FILTER ELEMENTS

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AIR CONDITIONING SYSTEM BASE MAINTENANCE (3)

FILTER ELEMENTS REMOVAL AND INSTALLATION (continued)

INSTALLATION OF THE FWD FILTER ELEMENTS

Follow the reverse removal sequence to install the FWD filter elements.

NOTE: Note: Make sure that the silicone seal is in good condition before you close the fasteners.

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Filter elements removal/installation

...

Job set-up

...

Aircraft maintenance configuration

Safety precautions

...

Procedure

...

Removal of the forward filter elements

Removal of the aft filter elements

Installation of the forward filter elements

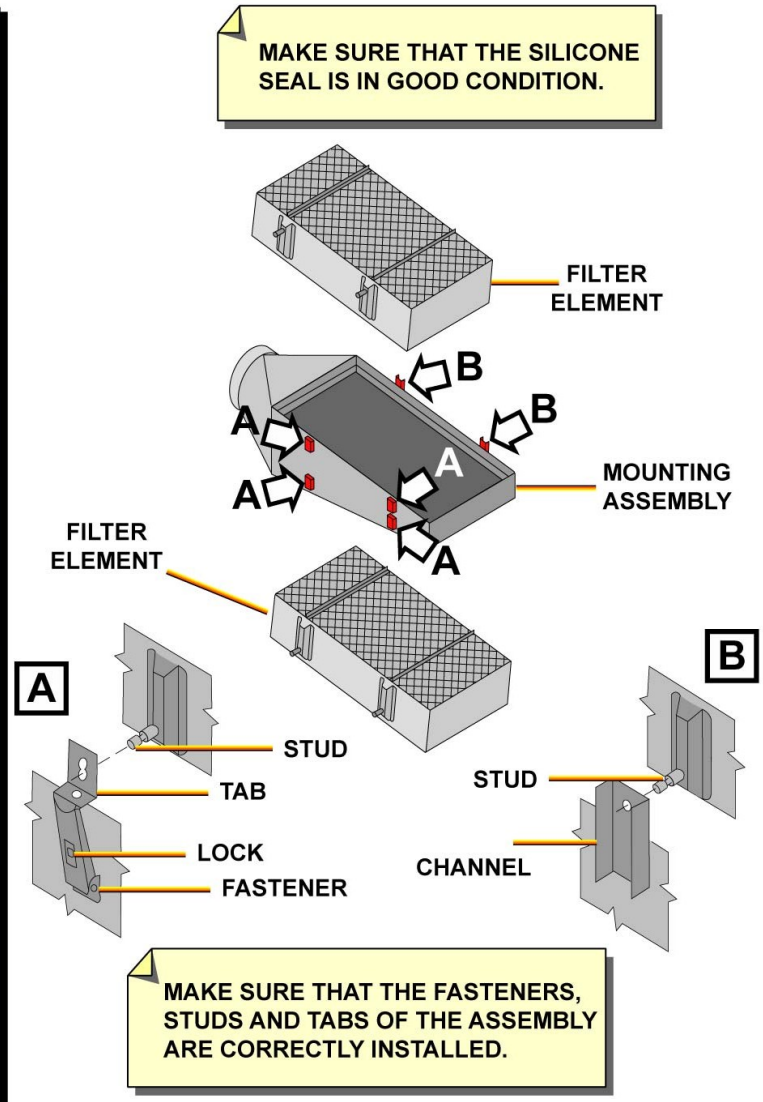
Engage the two studs in the related holes in the channels.
Put the two tabs in position and engage them in the grooves of the studs.
Close the fasteners.

Installation of the aft filter elements

...

Close-up

...



FWD FILTER ELEMENTS INSTALLATION

FILTER ELEMENTS REMOVAL AND INSTALLATION - INSTALLATION OF THE FWD FILTER ELEMENTS

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AIR CONDITIONING SYSTEM BASE MAINTENANCE (3)

FILTER ELEMENTS REMOVAL AND INSTALLATION (continued)

INSTALLATION OF THE AFT FILTER ELEMENTS

The AFT filter elements installation procedure is similar to the one for the FWD filter elements.
Remove all warning notices and close the FWD and AFT cargo compartment doors.

Filter elements removal/installation

...

✓ Job set-up

...

✓ Aircraft maintenance configuration

✓ Safety precautions

...

Procedure

...

✓ Removal of the forward filter elements

✓ Removal of the aft filter elements

✓ Installation of the forward filter elements

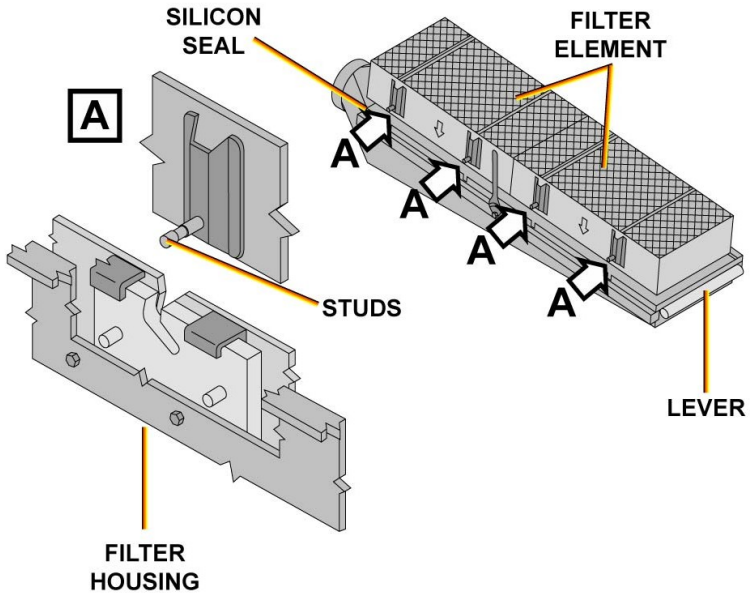
⇨ Installation of the aft filter elements

...

Close-up

...

MAKE SURE THAT THE SILICONE SEAL IS IN GOOD CONDITION.



FILTER ELEMENTS REMOVAL AND INSTALLATION - INSTALLATION OF THE AFT FILTER ELEMENTS

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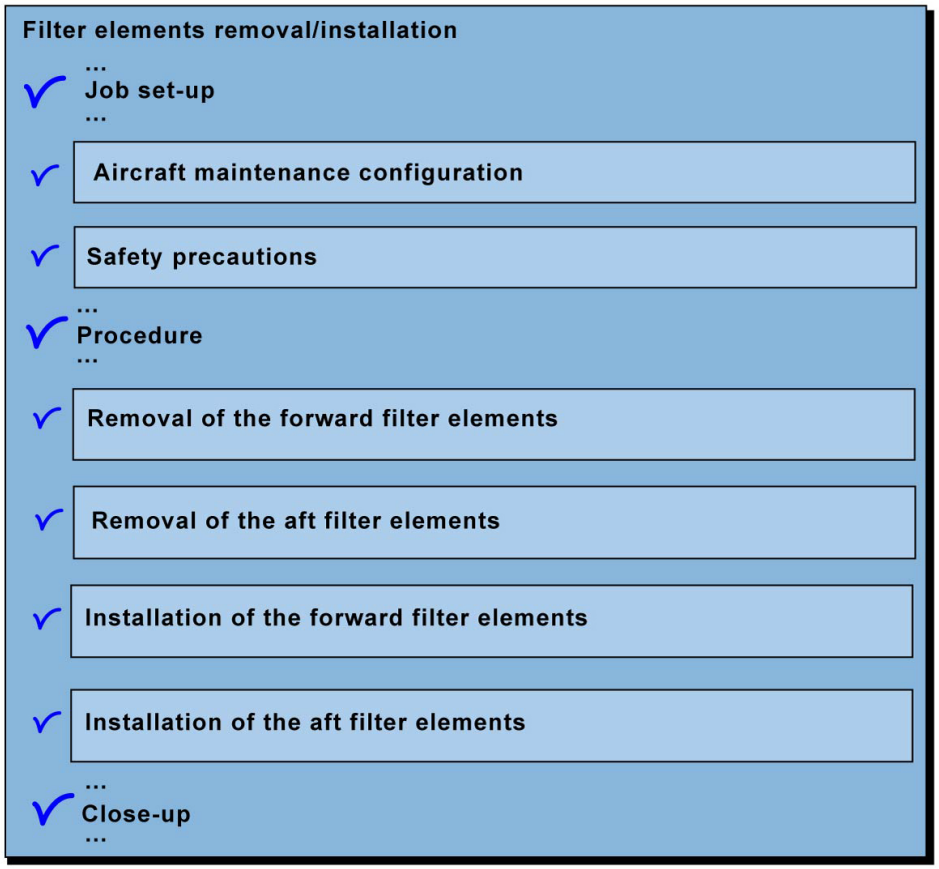

TASK COMPLETED

FILTER ELEMENTS REMOVAL AND INSTALLATION - INSTALLATION OF THE AFT FILTER ELEMENTS

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